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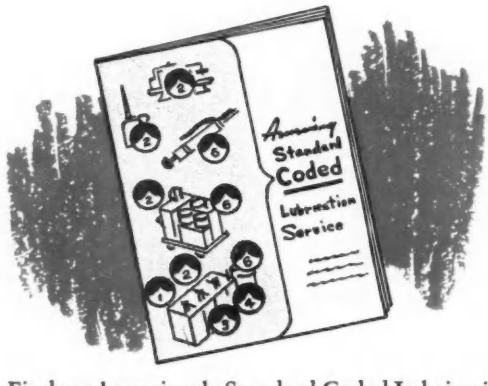

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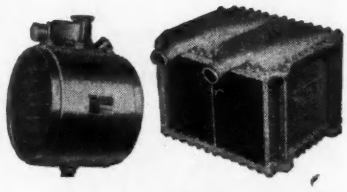

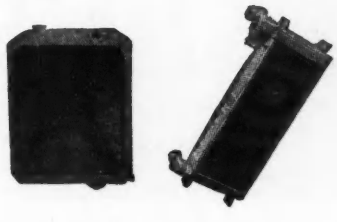

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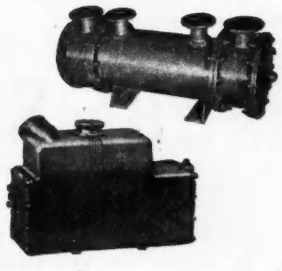

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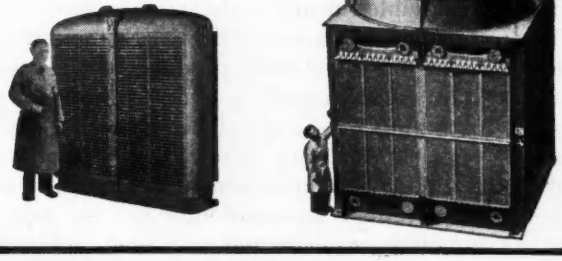

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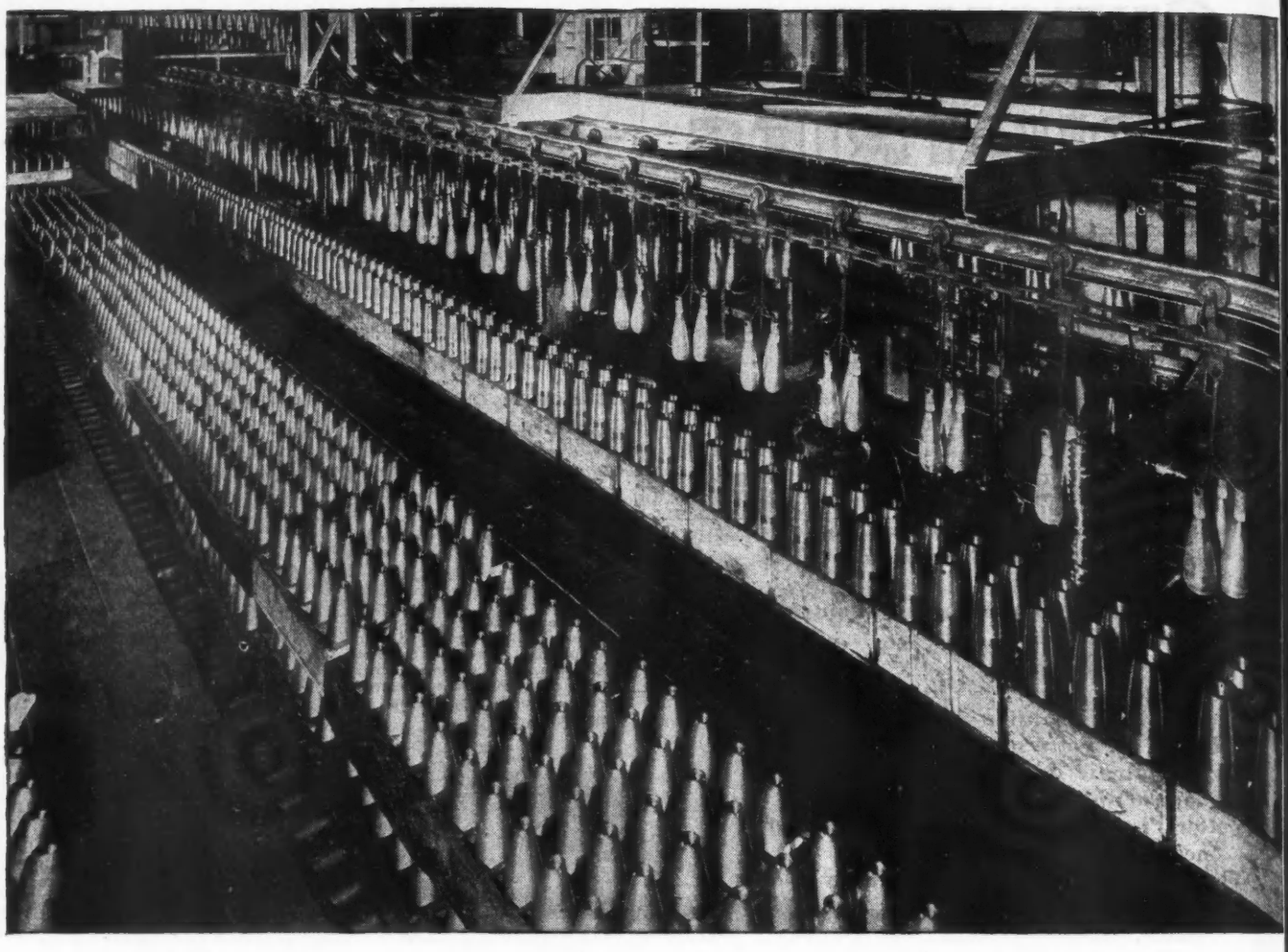

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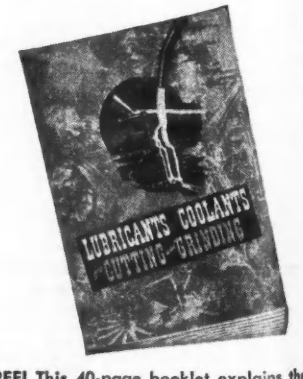

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Volume 92, No. 11

Treaties, Cartels and Planned Economy

By Julian Chase

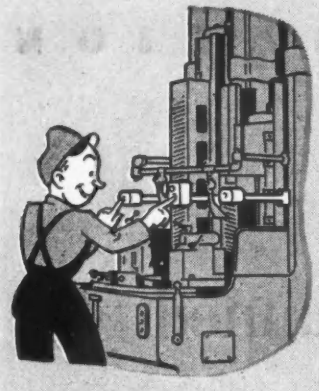
EARLY in May, the House of Representatives by a vote of 288 to 88 adopted a resolution to submit to the states a constitutional amendment altering the historic method of confirming treaties to which the United States is a party. As is well known, the Constitution now provides for ratification by a two-thirds vote of the Senate with the House having nothing to do about it. The House resolution, which may be killed by an unfavorable vote in the Senate before this is read, would give the House an equal share in the business of ratification which, under the proposed plan, would be accomplished by a majority vote in both branches of the Federal legislature.

What this attempt to discount the wisdom of the framers of the Constitution amounts to is to place the ratification of treaties on the same basis as the adoption of national laws. There is grave danger in such procedure as, for one thing, there is a fundamental difference between treaties with other nations and federal laws having force and effect solely within the United States. Such laws are subject to review by our own courts with the Supreme Court having the final word as to their constitutionality. Furthermore, they are repealable at the will of Congress under pressure of public opinion. But that is not true of treaties.

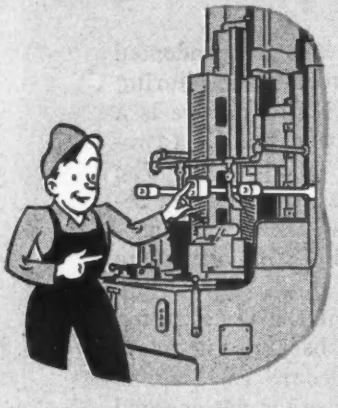
Unless we are to regard treaties as mere scraps of paper, we are in honor bound to abide by them. Our courts cannot set them aside. Our Congress cannot, except as their terms provide, put an end to them. Treaties, under our Constitution, are the supreme law of the land, taking precedence over state constitutions and Federal and state laws which are in conflict. "The conclusion of treaties," says Quincy Wright, authority on international law, "may unquestionably extend the power of Congress to provide for the exercise of police power within the state." Exactly that happened, to take one example, in the migratory bird case in Missouri which is on the records, among other designations, as Missouri vs. Holland, 252 U. S. 416. In that case, the Supreme Court, after having declared a certain act unconstitutional, sustained a similar one enacted pursuant to a subsequently ratified treaty with Great Britain.

All of this has a direct and important bearing on international cartels and the machinations of the advocate of a planned economy. If cartel treaties, such as are proposed by some delegates at San Francisco, are concluded, our Federal Government will acquire power to assume what would amount to absolute authority over the production and distribution, even within our own territorial limits, of the products covered. We should soon find ourselves involved in an extensive multiplication of the complications and ham-stringing restrictions of N.R.A. It is very much in the interest of the American free enterprise system, therefore, to leave our treaty-making machinery as it is and to keep treaty ratification as tough a process as it was originally designed to be.

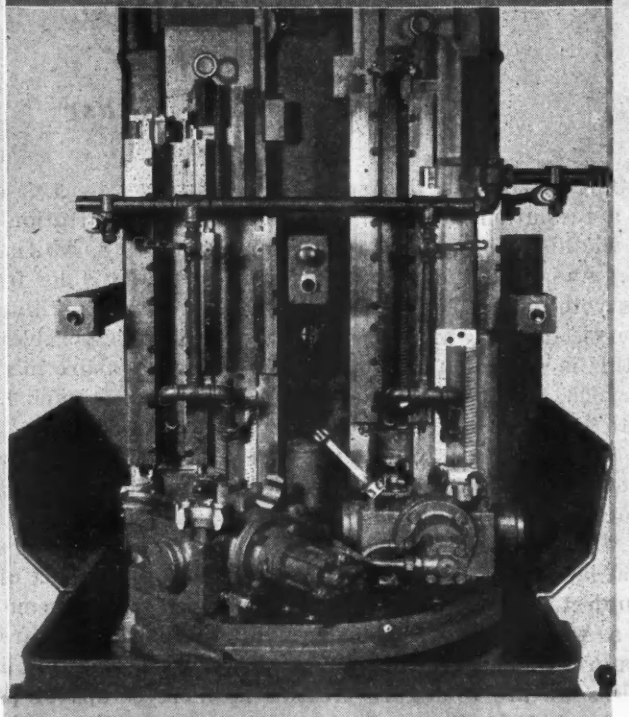
what is PRE-SET cycle control?



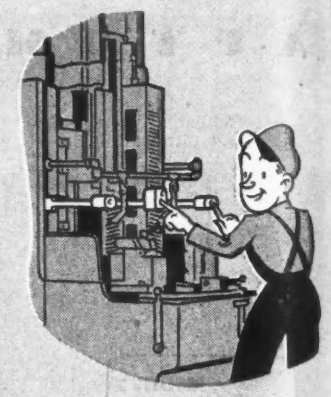
The left-hand fixture has been unloaded and properly reloaded, and the cycle will continue. (Drawing of operator pressing center and L.H. button.)



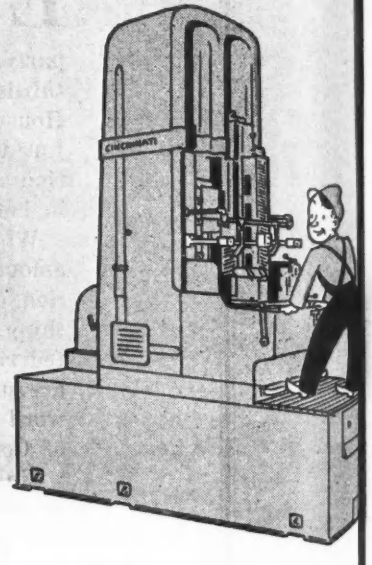
Operator reconsiders; does not want the ram to descend and stops the cycle. (Drawing of operator pressing red stop button.)



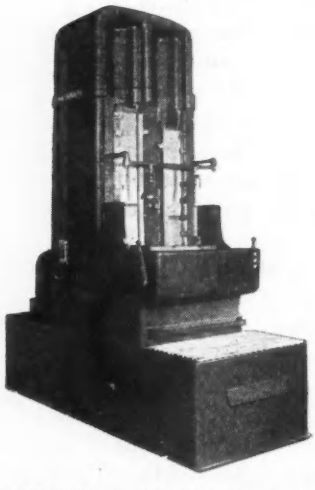
CINCINNATI No. 5-54 Duplex Vertical Hydro-Broach, equipped with pre-set cycle control, tooled up with automatic hydraulically operated fixtures for broaching several surfaces on rods and caps in pairs. Production, 325 rods and 325 caps per hour net.



The right-hand fixture has been unloaded and properly reloaded, and the cycle will continue. (Drawing of operator pressing center and R.H. button.



Operator stops complete mach



CINCINNATI No. 10-66 Duplex Vertical Hydro-Broach Machine. Also available in 1, 3, and 5 ton sizes. Write for catalog M-1387

Pre-set cycle control is an arrangement of electrical control buttons which enable the operator to continue or break the continuity of the automatic cycles, as desired, on CINCINNATI Duplex Hydro-Broach Machines.

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Government Coordination Lacking for Reconversion

Agencies Must Eliminate Conflicts in Their Activities and Release Surplus Machine Tools to Avoid Unnecessary Delays

By
Leonard
Westrate

Now that Germany has fallen and cutbacks and cancellations in war production are rapid and severe, there is a desperate urgency to clear the decks for immediate reconversion to civilian production. This is particularly true in the automobile industry, where unemployment already is casting an appreciable shadow. Unless the wheels of certain Government agencies start to turn faster than they have at this writing, the industry is not going to be able to absorb the large numbers of unemployed workers released from war jobs in time to avert a serious unemployment problem. Even the most vigorous action cannot stave off a period of inactivity for many workers, but the transition period can be shortened materially if the Government agencies and military services involved in reconversion will cooperate with each other and with industry and will coordinate their activities.

J. H. Marks, vice-president of Packard Motor Car Co. and chairman of the Contract Termination Committee of the Automotive Council for War Production, stated recently that "while the War Production Board, through its task committee, has been extremely helpful, there are other Government agencies to be considered and they must coordinate their efforts or all the preparations we are making now will bog down."

The automobile industry will apply full effort to the job of getting the wheels of civilian production rolling if it is given a free hand to do so. The most urgent problem, next to the acquisition of between 4000 and 5000 new machines, is the repossession of about 150,000 machine tools now shackled to war work. This does not mean pirating from war production those machines that cannot be replaced. However, there are now a great many Government-owned machines gathering dust in inventory which may either be substituted for those needed machines or turned over to the manufacturer in exchange for his machines which are on war work.

The next most important problem is to get from surplus inventories of the various Government agencies and procurement services the additional machine tools needed for civilian production. Both industry and Government know the machines are available; both agree in principle that the machine should be made available for reconversion purposes, but thus far the mechanics of the transfer have been buried under confusion, inertia, and—most important of all—lack of uniform workable procedures and coordination between the multiplicity of Government agencies owning them. The right hand knoweth not what the left hand doth.

There is no discernible opposition on a policy level from the owning agencies so far as release of company-owned machinery is concerned. On at least three occasions during the last several months, they have agreed to such proposals. However, at that stage creeping paralysis set it, and nothing was done to clothe words with action. Automotive industry leaders say that what is necessary to break the jam is for *all* procurement agencies to correct any phrase-

(*Turn to page* 78, *please*)

Measurement of Maneuvering L

DURING the past twenty years improvements in aircraft design have to a large measure been due to aerodynamic theory and wind tunnel tests. There has been, however, one major weakness in both design tools and that has been in dealing with dynamic or non-uniform conditions. This is not because these two methods cannot handle dynamic conditions, for quite the reverse is the case, but it does mean that serious difficulties and complications are encountered. Spin tunnels have been very successful in giving the general behavior of an airplane, but they have produced very little quantitative data. Gust tunnels have encountered great difficulties in accurately measuring the dynamic loads and assimilating actual conditions.

Large aircraft design has been seriously impeded because of a lack of accurate knowledge of basic loads resulting from maneuvers. Many of the design loads for structural components of an airplane are governed by maneuvering loads. Due to this lack of information, the maneuvering loads required by the Civil Aeronautics Authority are based on an arbitrary normal force coefficient for the surface and the maneuvering speed, with the additional specification that the load need not be greater than that which is possible to obtain with a certain applied control force. Interest in dynamic loads has been greatly stimulated in recent years because of service failures, particularly of horizontal surfaces, which have occurred on several types of aircraft. Research work has been carried on by several organizations along both analytical and experimental lines. The analytical work has suffered for lack of sufficient flight data. Most calculations of maneuvering loads required a fundamental assumption of a certain rate of control surface movements. As this article will show and as was brought out by W. W. Beman and E. C. Frost in Reference I, maneuvering loads appear to be a complicated function of not only what the airplane and its control system can do but, in addition, what the pilot will or chooses to do (Ref. 2). The experimental work has been handicapped because of the difficulties of making accurate measurements in flight and the absence of adequate instruments or methods. In general the structural measurements made in flight in the past have been very crude. Scratch gages, deflection photographs, pressure distributions, and transit measurements of deflections have been made. By far, the majority of measurements made during maneuvers has been with accelerometers. None of these methods

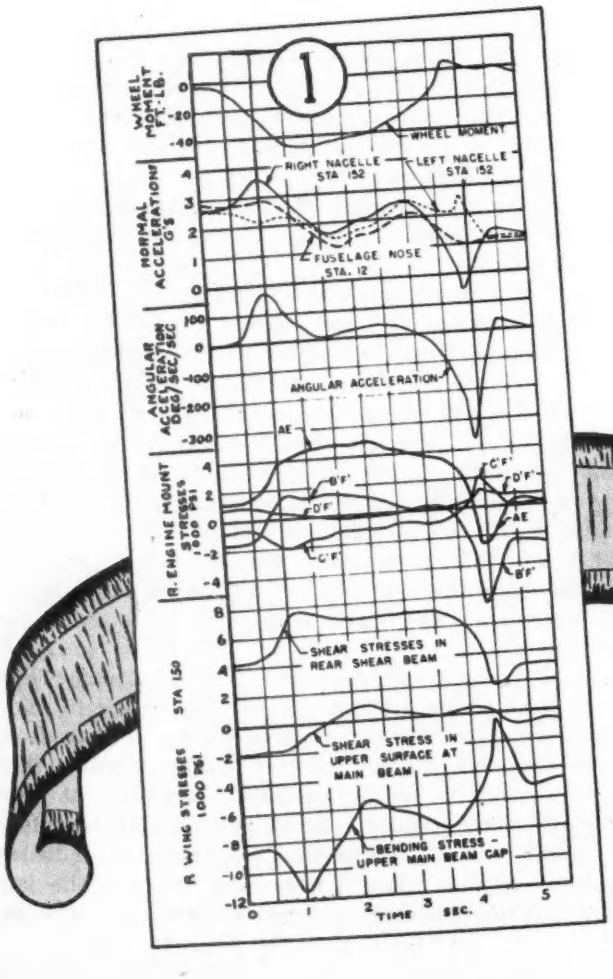


Fig. 1. Stresses Measured in a P-38 During a 360 Degree Left Roll while in a Banked Turn

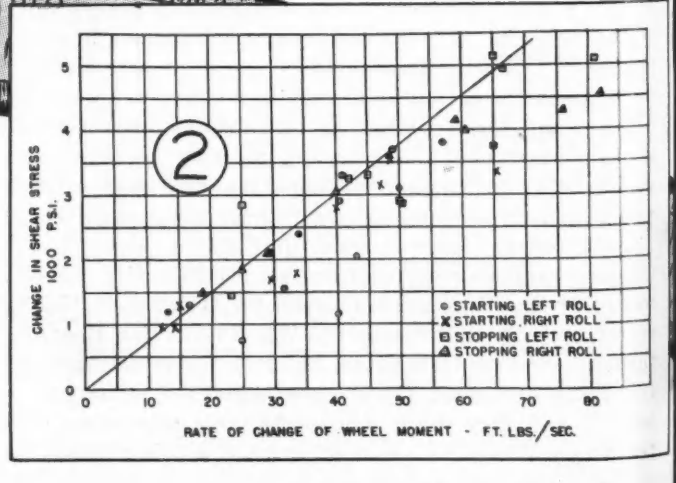

2
CHANGE IN SHEAR STRESS 1000 P.S.I.
STARTING LEFT ROLL
STARTING RIGHT ROLL
STOPPING LEFT ROLL
STOPPING RIGHT ROLL
RATE OF CHANGE OF WHEEL MOMENT - FT. LBS./SEC.

Fig. 2. Maneuvering Stresses in P-38 Rear Shear Beam vs. Rate of Change of Aileron Control Force

Loads in Flight

By C. J. Buzzetti and W. L. Howland
Lockheed Aircraft Corp.

have satisfactorily given the maneuvering load or stresses on the structure.

With the advent of wire resistance strain gages, the measurement of maneuvering loads in flight becomes possible and feasible. The technique of making stress measurements in flight has advanced a great deal in the past few years. It is the object of this article to describe some of the work carried on along this line at Lockheed Aircraft Corp. Throughout this article the term "maneuvering stress" is taken to mean that increment in stress which is caused by or entirely dependent upon the maneuver being made. (Maneuvering stress = total stress minus balancing stress.)

Instrumentation

The wire resistance type strain gage is a perfect solution to many of the instrumentation problems connected with structural flight testing. They are by their very nature remote reading. Gages can easily be mounted on the structure almost anywhere, once the technique of attaching has been developed. Wire resistance type strain gages were used to measure boom and fuselage bending moments, wing stresses, stabilizer stresses, accelerations, control forces, control surface hinge moments and surface positions during the tests to ascertain maneuvering loads.

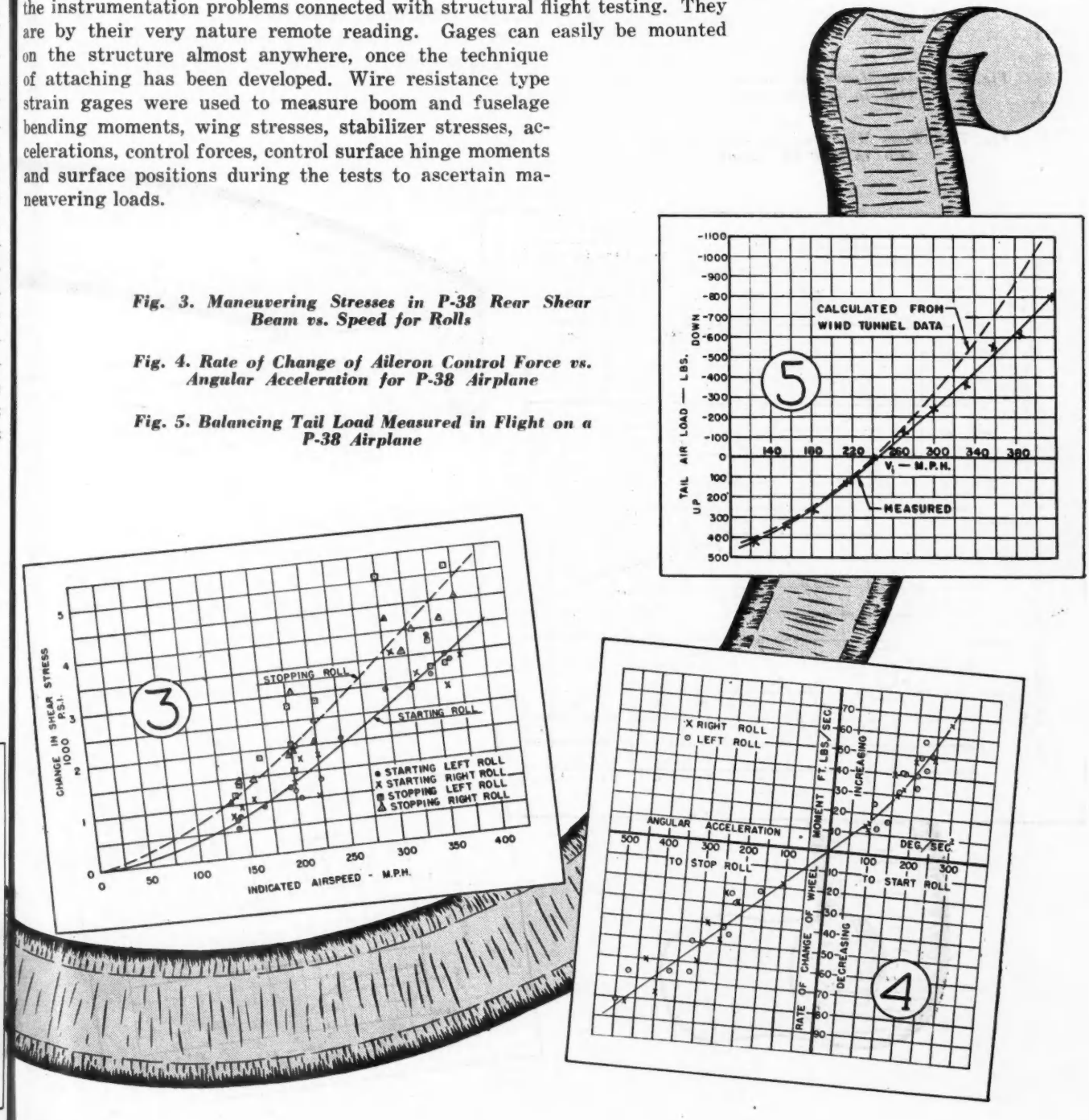


Fig. 3. Maneuvering Stresses in P-38 Rear Shear Beam vs. Speed for Rolls

Fig. 4. Rate of Change of Aileron Control Force vs. Angular Acceleration for P-38 Airplane

Fig. 5. Balancing Tail Load Measured in Flight on a P-38 Airplane

In order to accurately measure fast changes in stress such as during a maneuver or a landing the output from the strain gage bridge circuits are recorded on a twelve channel oscillograph. This installation will record accurately frequencies up to 40 to 50 cycles per second without the use of amplifiers.

Roll Tests

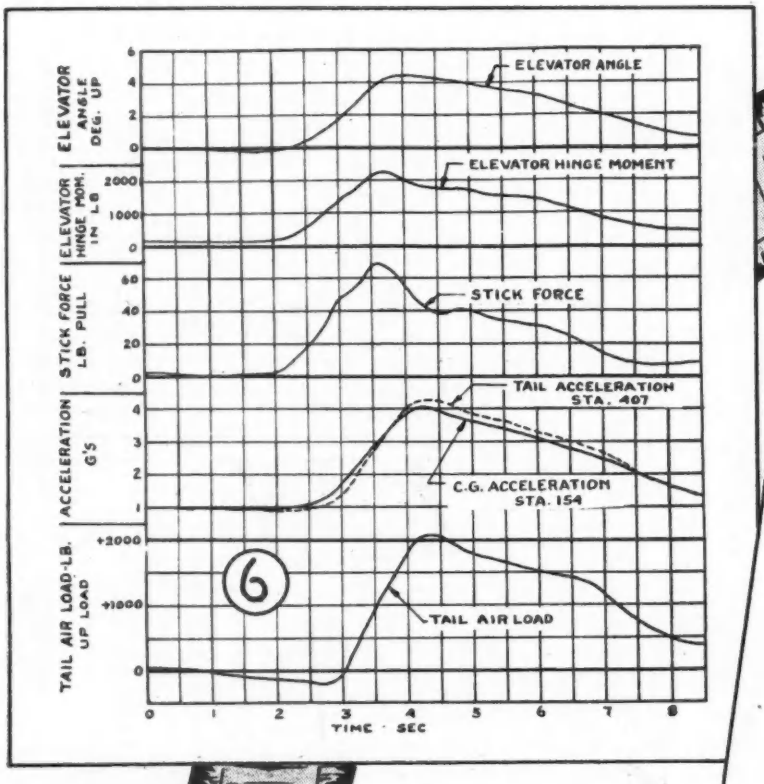
One of the most common maneuvers performed with a fighter airplane is a roll. Recently a series of roll tests were conducted on a P-38 airplane to determine the operating characteristics of a hydraulic booster on the aileron control system and to measure the stresses caused in the airplane's structure due to the high rates of roll. Calculations based on the predicted roll performance indicated that the engine mount might become critical under side loads (centrifugal force). Also the wing might be critical as a result of forces caused by large deflections of the aileron at high airplane speeds, the large aileron loads being made possible by the booster system.

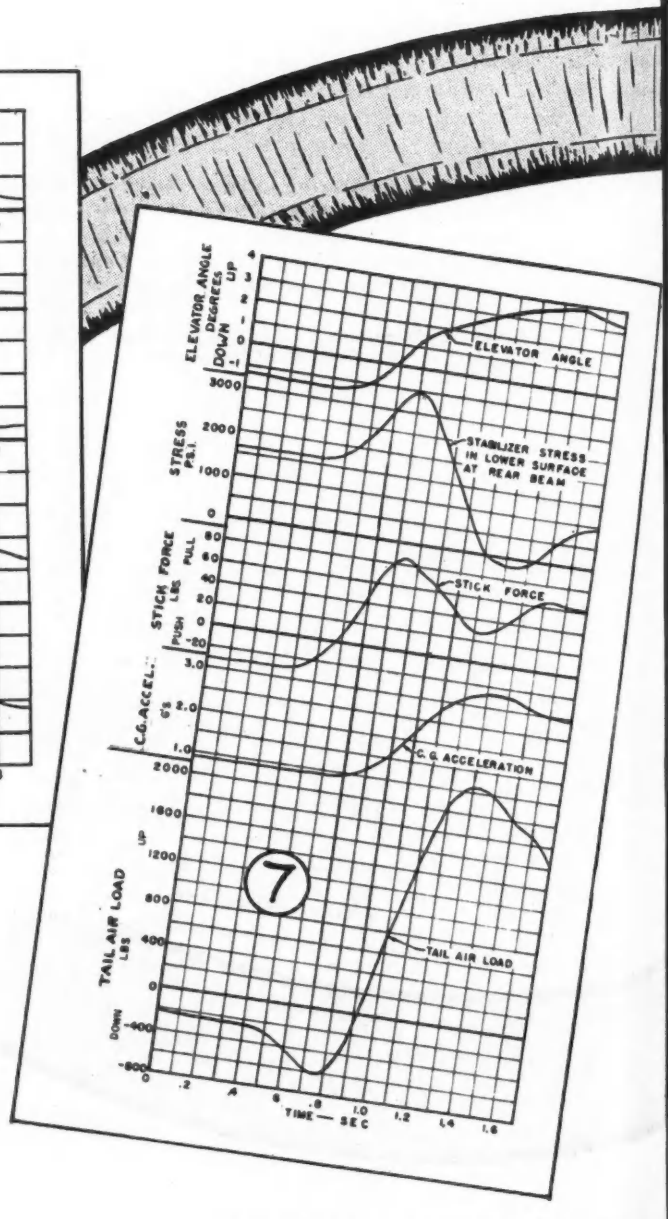
In addition to the many quantities which were recorded by the automatic observer camera, eleven items were measured with electrical strain gage bridges and recorded simultaneously on a Miller oscillograph. The aileron control loads were measured by means of a strain gage bridge placed on the spokes of the control wheel such that it only responded to a twisting moment applied to the wheel and was independent of fore and aft loads.

Results of some of the stress measurements made during the roll tests are shown in Figs. 1, 2, 3 and 4. Fig. 1 shows the stresses measured during a 360 deg. left roll while in a banked turn. The top curve in Fig. 1, is the control wheel moment exerted by the pilot. The next three curves are the accelerations measured at the right and left nacelles and at the fuselage nose. Note that all three accelerometers are at about 2.75 G's at the start of the record. This is the result of the steady turn. The next lower curve is the angular ac-

Fig. 6 Stresses Measured During a 4 "G" Pull-Out in a P-38 Airplane

Fig. 7. Stresses Measured During a Rapid Pull-Out in a P-38 Airplane





celeration of airplane caused by the aileron movement. This curve was calculated from the normal accelerations in each nacelle and knowing the distance between them. The lower seven curves are stresses in various members in the airplane and engine mount.

In all maneuvers the engine mount stresses were found to be very low. The maximum values recorded in any engine member during any rolling maneuver was +7200 psi and —6500 psi. To substantiate the low engine mount stress values measured in flight and to obtain the load distribution for different loading conditions a series of static tests were conducted on the right engine mount. These static tests showed that the mount stresses actually were low and that the cowling and its support structure were evidently taking most of the load. Static tests were made with and without the cowling. Since the cowling was not taken into account in the stress analysis it means that the engine support is actually way over strength. Here is an example where, had it not been for structural flight measurement needless weight would have been added to the engine support structure.

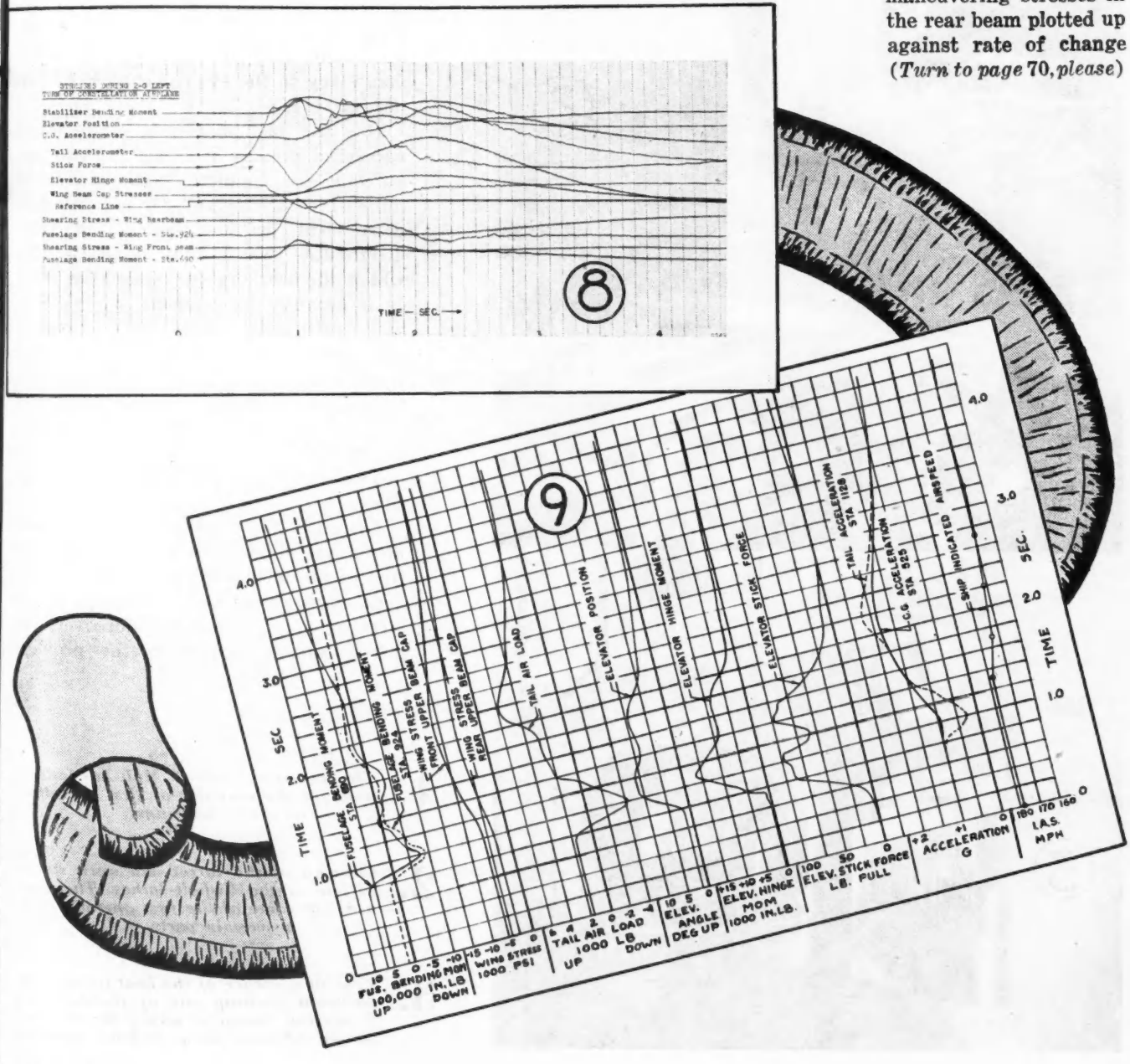
The shear stresses measured in the rear shear beam were quite high in comparison with the allowable stresses; the maximum value measured being +7600 psi. Positive shear stresses are considered as those resulting from a diving moment on the wing, thus positive shear in the rear beam indicates an up load on the rear beam.

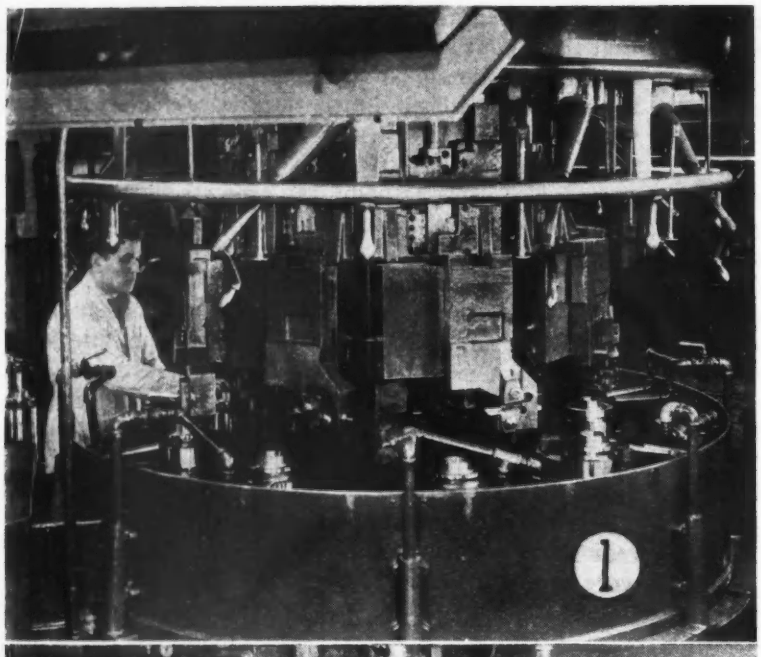
Due to the interesting nature and magnitude of the rear shear beam stresses during the rolls, the data were carefully investigated. One of the results of the analysis is given in Fig. 2. This figure shows the maneuvering stresses in the rear beam plotted up against rate of change

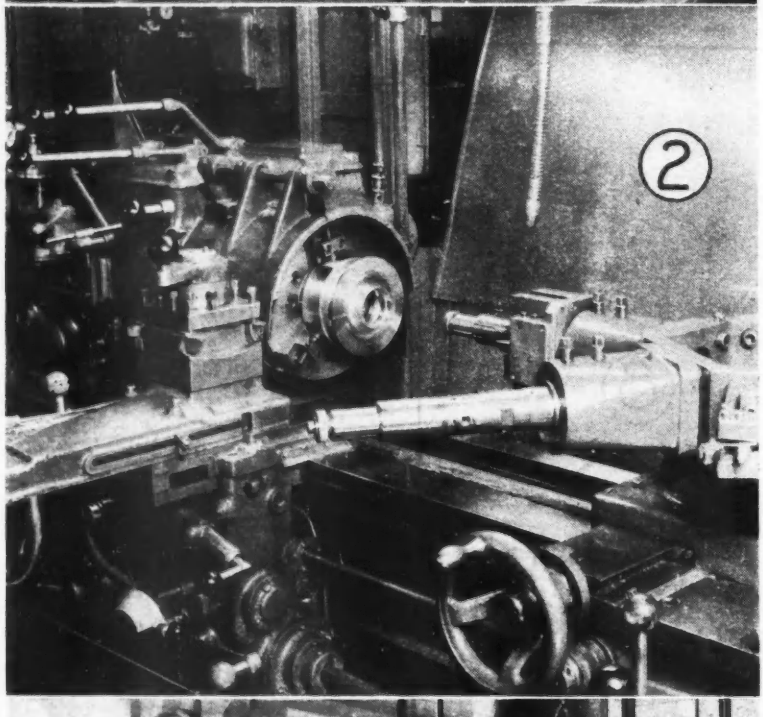
(*Turn to page 70, please*)

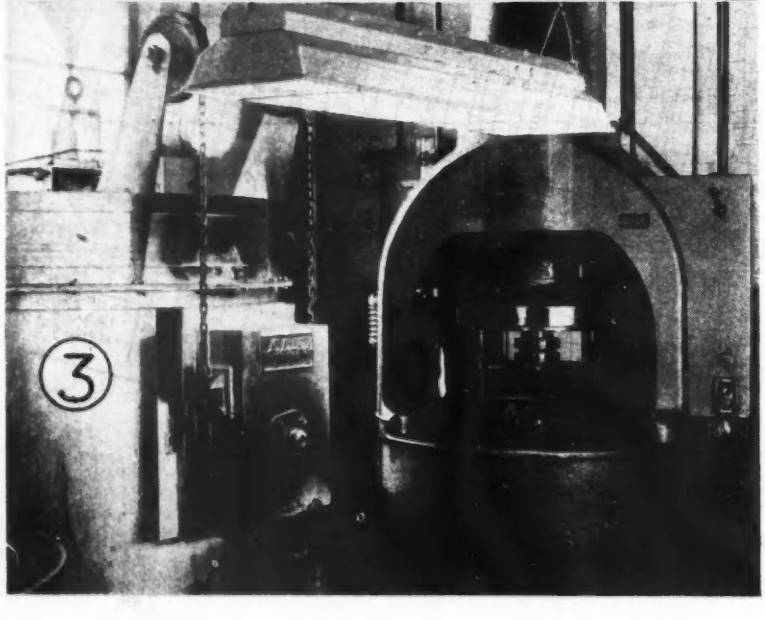
Fig. 8. Oscillograph Record of Stresses During a 2 "G" Turn in a Constellation Airplane

Fig. 9. Maneuvering Loads Obtained from the Oscillograph Record Shown in Fig. 8, i.e. 2 "G" Turn in a Constellation Airplane









The

By Joseph Geschelin

A DARING application of human relationship principles in management has spun an aura of industrial romance about Jack & Heintz, Inc., of Cleveland, one of the largest producers of starters and generators, automatic pilots, flight instruments, servo units and energizers for aircraft, and has inspired a multiplicity of magazine and newspaper articles. Much of what has been written stems from the observations of individuals—each of whom has sought to find a single key to the evident success of this organization.

Has the Jack & Heintz organization succeeded because it serves to each employe a hot balanced meal—plus vitamins—free of charge? Or because each department provides coffee and fresh doughnuts twenty-four hours a day which the workers can sample at will? Is it because the company fits workers with orthopedic shoes—free—so they may work 12 hours a day seven days a week free from fatigue? Is it confirmation of a belief that if people are placed on their honor they will react favorably? For here the "associates" are paid on an hourly basis but do not punch time clocks.

Evidently the answer must be sought not in any single step but in a combination of all devices known to an enlightened management in its dealings with a large group of employes. Moreover, the purely human aspects of the problem

1. ***The versatile Bullard Mult-Au-Matic is used for the majority of first operations on starter housings.***

2. ***Close-up of the turret and work station of one of the Gisholt lathes. These are used for some of the first operation jobs on certain parts.***

3. ***View of a corner of the heat treating department showing one of the Lindberg Hydryzing furnaces, served by its companion Gleason die-quenching machine.***

Production Side of Jack & Heintz

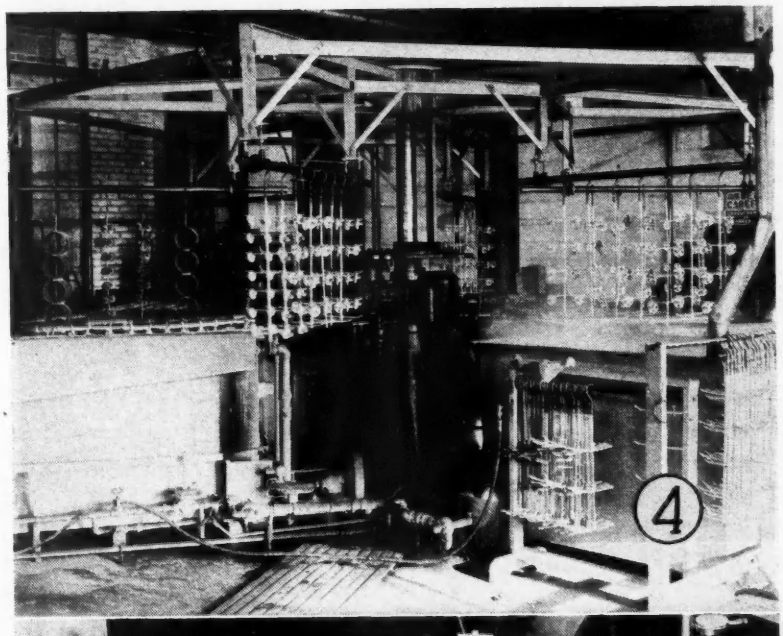
needs must be interwoven with advanced thinking in terms of product design and production and management engineering.

Bill Jack, the founder of this unique organization, has had extensive experience in management and human relations as well. He established progressively such companies as—Accurate Machine Co., The Manifold Co., Marquette Metal Products, and latterly the Pump Engineering Service Corp., now the Pesco Products Div., Borg-Warner Corp. Jack & Heintz was formed in 1940 in association with Ralph M. Heintz, a pioneer in the development of electronic equipment. In 1911 Bill Jack was initiated into the International Association of Machinists and subsequently became business agent for the Cleveland District. Today all Jack & Heintz associates are members of that organization. The company employs some 8700 people, who are putting in 12 hours a day seven days a week.

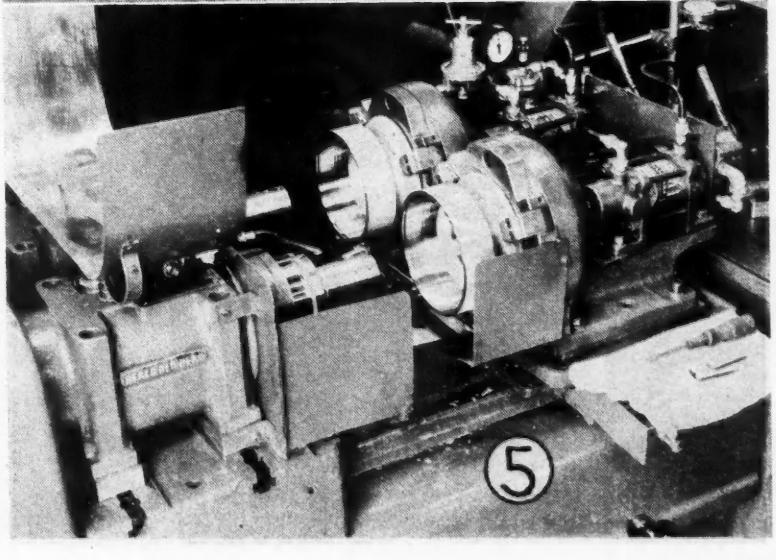
We tried to find the key to the Jack & Heintz enigma by an objective view of the mechanical operation of the plant. But it is impossible to divorce the machine from its human operator in this plant. Unless all of the forces at play are considered, you cannot put your finger on the answer.

From a technical standpoint one fact is clear. The company has analyzed each product and has consciously re-designed it for mass production. It is not news to our readers that most of the technical products for military aircraft had their beginnings as laboratory equipment and few had the benefit of mass-production planning for manufacture when the war began. The basic philosophy, then, has been to design each item suitable for low-cost mass-production. It is claimed that although each item made by the company is interchangeable from the standpoint of physical mounting and performance characteristics with similar equipment made by others, the

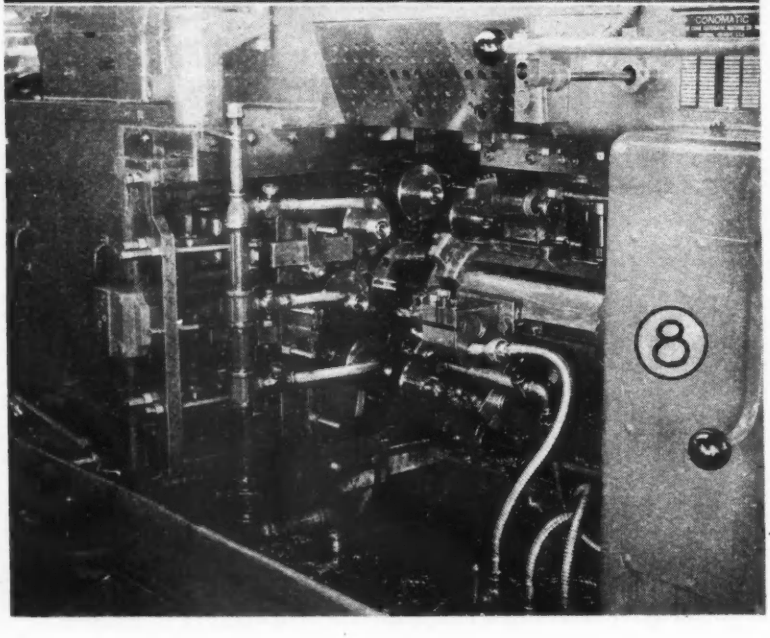
This is the 106th in the series of monthly production features



4. ***Bullard-Dunn Process machine in the heat treating department. Following the drawing operation the work goes to this machine for descaling.***



5. ***Single-end, two-spindle Heald Bore-Matic finish-bores the bearing seat in the starter housing. This operation is held consistently to limits of 0.0005 in.***



internal parts and assemblies may be quite different.

Design for mass-production then is teamed up with good production techniques based upon advanced practice known to industry. The fact that this is coupled with the use of the latest type of machinery known to the art is simply following the general practice of other producers in the industry.

The use of rewards or incentives for suggestions leading to improvements in manufacturing practice certainly is not a new idea. But at Jack & Heintz the play of the other human equations—the honor system, freedom from restraints, high earnings, and the like—appear to make the suggestion system more productive. For example, it is said that on numerous occasions a group of people in a department will get together on the problem of machining a part having a multiplicity of steps in its routing and visualize a setup in which the same part might be finished completely within one special machine. At this stage the management is called in and the production engineers are given the job of working out the idea and translating it into a single-purpose machine. They have many of these in various parts of the plant today. That, too, is not a new concept. Most of the plants of our industry have single-purpose equipment for large runs. The difference, it seems, lies in the fact that the basic idea was generated by the workers themselves with no thought of opposing an approach which is frankly in the sphere of labor-displacement.

Jack & Heintz operates some ten plants in the Cleveland area. Owing to the multiplicity of products the plant layout is functional or departmentalized as contrasted with straight-line production in which a given part is completed in its entirety in a single department. In the case of electrical equipment, for example, they produce 15 different starters and two different generators. Parts for all of these are machined in a single building

6. ***Splines and gear teeth are cut on Fellows gear shapers, part of a battery of these machines being shown here.***

7. ***A battery of Greenlee automatics used for the production of a variety of small parts.***

8. ***Close-up of the work section of one of the huge Conomatics. They produce the endless variety of small parts such as gear blanks formed from bar stock.***

by routing through the various departments. The major departments may be outlined as follows:

Automatics & Screw Machines—including National Acme-Gridleys, New Britain-Gridleys, Conomatics, Greenlee automatics, Wickham automatics.
Turret Lathes—Warner & Swasey, Gisholt, Bullard Mult-Au-Matic.
Drill Press—Natco multiple-spindle, Delta bench type, Edlund single-spindle.
Gear Cutting—Fellows gear shapers, Gleason gear generators.
Precision boring—Heald Bore-Matics, Ex-Cell-O boring machines.
Grinding—including a battery of Norton grinders.

In addition, there are Ex-Cell-O precision thread grinders and the single-purpose machines built by the company, primarily multiple-head horizonal drills.

Departmentalization of this order does not lend itself to conveyorization, particularly when it is considered that assembly is done in other plants to which the parts must be transported. Materials handling, therefore, is done by hand lift trucks and electric industrial trucks. However, some assembly departments show a generous use of gravity roller conveyor lines for linking the bench operations.

Supplementing the machine shop facilities are the other process departments required for an operation of this scope. For one thing there is a comprehensive welding department. Here are a number of specially designed Lincoln Electric Co. automatic head welding machines for butt-welding frames. In this instance the problem is to weld the outer steel shells to a center shell of Armco iron. Then there is a five-head Oxweld torch cutting machine with automatic traverse attachment for cutting a multiplicity of windows in steel frames.

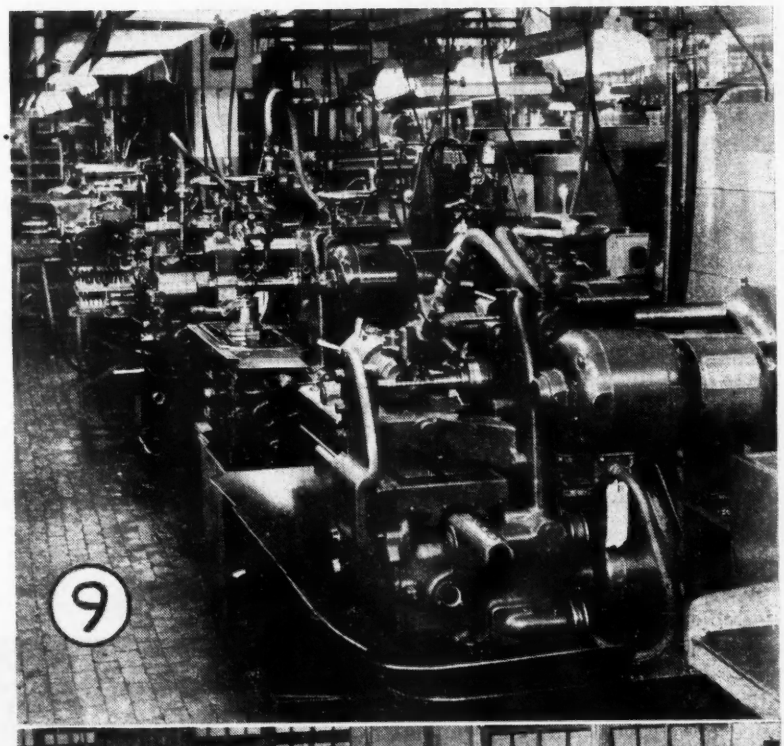
Then there is an electroplating and chemical finishing department. One section is equipped for anodizing many of the non-ferrous parts. A Bullard-Dunn processing machine also is found here. An important part is played by the "hard" chromium plating department. Certain wearing parts are coated with "hard" chromium to increase service life. However, the process also is applied as a means of salvaging parts which have come out undersize in machining or grinding. This procedure has been approved by the Armed services as a means of reducing scrap and improving costs thereby. Process equipment also is available for applying the well-known Houghton-Black finish on certain parts. Blakeslee degreasing machines are used for cleaning parts after machining and after heat treatment.

In keeping with modern practice cemented-carbide tools of proper grade are widely used for metal removal on various machines. These tools are prepared ground to form, and maintained by a special carbide tool room provided with the latest types of equipment for brazing and form-grinding. Formed carbide tools of intricate shape are ground in Wickham optical type machines.

Starters are assembled in a separate building on individual benches linked by a comprehensive system of gravity roller conveyors. This building also contains a paint shop in which the parts are sprayed in DeVilbiss booths, then mounted on an overhead monorail conveyor for drying in infra-red lamp ovens.

With this generalized picture of the overall operation in mind, we have selected the starter housing as a specific example for study. The following brief outline of some of the major steps in the machine shops

(*Turn to page* 82, *please*)



9. ***Part of a battery of versatile Brown & Sharpe milling machines.***

10. ***A view in the starter assembly department. The assembly has been completed and tested in another section and at this stage the operators complete the safety wiring procedure preparatory to shipment. Note the gravity roller conveyor in the foreground.***

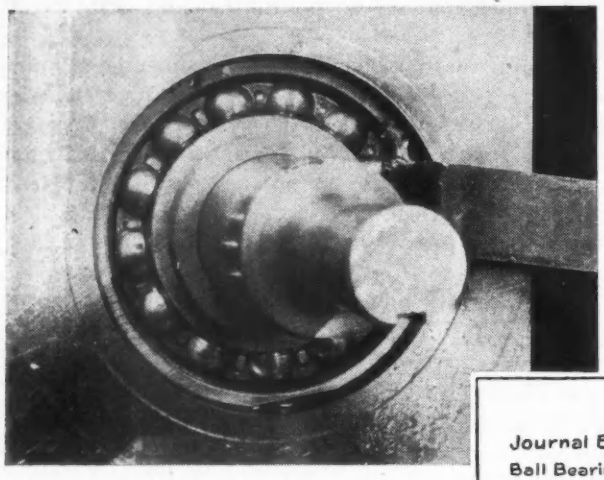


Fig. 1B—(Above) Ball bearing in test set-up.

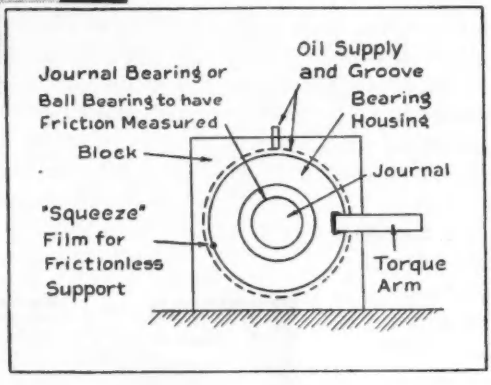


Fig. 1A—(Right) Schematic drawing of bearing support set-up.

By Arthur F. Underwood

Head, Mechanical Engineering Dept. 5
Research Laboratories Division,
General Motors Corporation

THE basis for supporting a load by a bearing on an oil film has been stated to require the development and maintenance of a wedge film between two surfaces by a relative tangential motion. An important corollary has been that two flat parallel bearing surfaces would not support a load of an oil film. These facts led to machining a bearing with the proper clearance and to such special bearing types as the Kingsbury thrust bearing to furnish a load-carrying oil film wedge. While practically all the available literature on oil film theory is on uni-directionally loaded bearings, those bearings having alternating or rotating loads are a very important class.

Our experience has shown that there has been an unaccountable difference between the performance of a given journal bearing when carrying a load of constant direction, compared to one carrying a load which revolves in direction around the stationary bearing support. From a practical standpoint, this meant that a bearing having a rotating load would support a far greater load than one having a uni-directional load. In addition, a need has existed for a long time in our laboratories, for a means to measure the friction of a bearing supporting a rotating load. Based on a known phenomenon, an idea was devised to allow the cradling of such a bearing on a frictionless support and at the same time to make it fairly rigid. This article describes the experiments conducted on such a device and presents a new theory of the action of the oil film on a bearing under a rotating load.

Numerous investigators have shown that two smooth flat surfaces with oil between them, gradually approach one another by squeezing out the oil when a load is applied between them. By the proper mathematics, it can be shown by Reynolds' basic equation that the time-rate for two plates to approach each other is:

$$t = \frac{3\pi\mu a^4}{4W}\left(\frac{1}{h_2^2} - \frac{1}{h_1^2}\right) \quad \ldots\ldots\ldots \quad (1)$$

where t = time to change the clearance between the plates from h_1 to h_2.

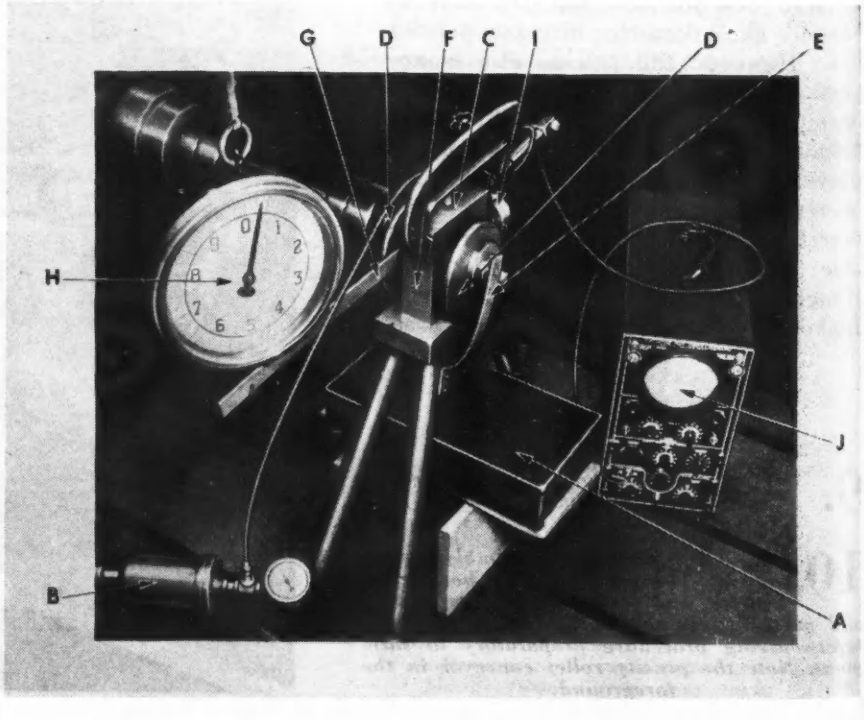


Fig. 2—Set-up for testing bearing support.

Rotating-Load Bearings

A new concept of operation and a Frictionless Support

μ = viscosity of liquid between the surfaces.
a = radius of circular plate.
W = force applied mutually between the plates.

The formula shows that the time required for two smooth, flat plates to approach one another is proportional to the viscosity, the area and the term within the parentheses, and is inversely proportional to the force. Consideration of the term within the parentheses shows that (1) beginning with any original clearance a definite time is required to halve the clearance, (2) to subsequently halve the clearance again will require the original time multiplied by four, etc.

Frictionless Support For a Bearing

With this background, the idea was evolved that a plain cylindrical bearing housing (Fig. 1A) could be fitted with clearance inside of a substantial supporting block. In turn, the bearing with its rotating load would be solidly inserted within the housing. There would be no rotation between the housing and the outermost block other than required for torque measurement. However, as the load rotated, the housing surface would try to approach the inner surface of the block but because of the constant change in the direction of load, the bearing housing would constantly be trying to approach a different area of the block. In this way the rotating load is always trying to squeeze out a new film of oil. It should be clearly understood that the oil film existing at this point is not produced by a relative velocity between the two surfaces as is developed in a regular rotating bearing and has been termed "squeeze film" to so distinguish it.

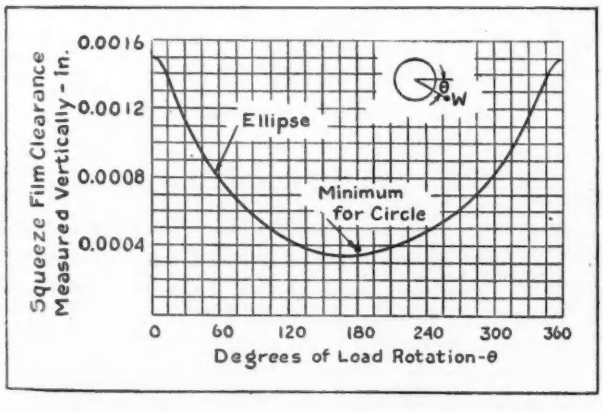


Fig. 3—Variation of squeeze film clearance as a load is applied to one-half of a bearing. Bearing 2¾ in. diam. by 1⅜ in. width; based on elliptical discs; 400 pd. peak load; 3000 rpm; 0.0015 in. original clearance; 100 Saybolt viscosity oil.

Because the outer surface of the bearing housing is supported away from the inner surface of the block by squeeze-oil film, there is no resistance to relative motion between these two surfaces in any direction, that is to say, the bearing housing can be rotated by any force which is applied to it. If a journal and a bearing (Fig. 1A) are inserted in the bearing housing, any frictional torque on the bearing housing can be measured by a torque arm secured to it.

To test the validity of the idea, a simple test set-up was made. A ball bearing was employed since it was readily available and its outer race could be used as the bearing housing in the manner described immediately above. The ball bearing in (Fig. 1B), produced a frictional torque on its outer race when the shaft was revolved. Clearance was made between the outside of the outer race and the large block by fine lapping. Extending to the right, out of the picture (Fig. 1B) is the torque arm which was firmly welded to the outer ball bearing race. To insure the replacement of the oil, a circumferential groove was cut at the center of the hole in the block.

Fig. 2 shows the complete set-up, a dynamometer being employed to turn the shaft and ball bearing. Oil from the sump (*A*) was pumped by an electrically operated pump (not shown) through filter (*B*) to inlet (*C*). As described in the previous paragraph, the lubricant then enters the clearance space between the lapped hole in block (*F*) and the outer lapped surface of the outer race. Drain grooves return the oil to sump (*A*). The journal is restrained endwise by a steel spring (*E*) having a ¼-in. ball in the center of the journal. Two eccentric weights (*D*) keyed to the journal, are used to produce the rotating load on the ball bearing. (*G*) is the torque arm which together with scale (*H*) measures the friction torque of the ball bearing.

A Brush pick-up (*I*) was mounted securely to the block (*F*) with the large clamp at the center top of Fig. 2. A hole was drilled through block (*F*) at the horizontal center, through which a sufficiently long pin was inserted to allow the inner end to be in contact with the outside of the outer ball race, and the outer end of the pin to be in contact with the prong of the pick-up. Any horizontal relative movement between the

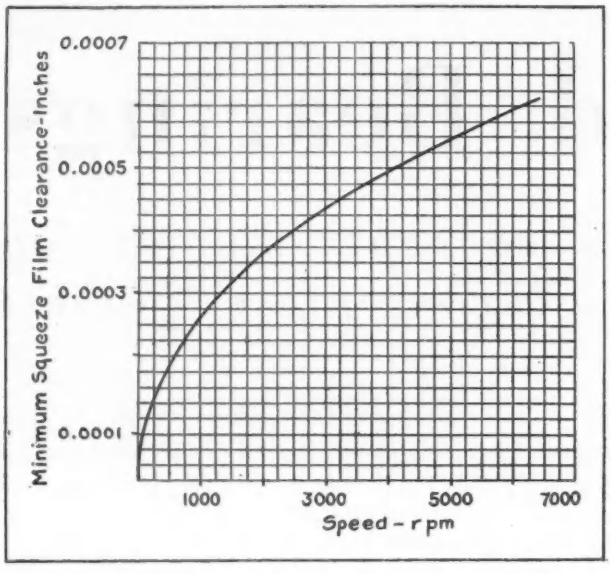


Fig. 4—Effect of rpm on minimum squeeze film clearance. Conditions same as Fig. 3.

outer ball race and block (F) would be measured by the pick-up, which was shown on oscilloscope (J) as a wave having one cycle per journal revolution.

When the shaft was not turning, the torque arm was sticky and as shown in Fig. 2, the scale would not necessarily read zero. This is caused by the metal-to-metal contact. But as the speed is increased with the oil pump on, the rotating load from the eccentric weights will begin to squeeze out the oil in a continuously varying (rotating) direction. Above a certain speed, the torque arm becomes perfectly free and the scale reads the friction torque of the ball bearing.

After the speed is high enough, a variation in oil supply pressure is interesting. At zero pressure, the torque arm is sticky but as the pressure is raised to a certain value, the freedom is increased until above a critical supply pressure the arm is perfectly free. The oscilloscope wave shows a corresponding difference. With no oil supply, the wave has a large amplitude indicating an extensive movement of the ball bearing within the block. When sufficient oil pressure is supplied, the motion is greatly reduced, showing how the shaft eccentricity is greatly damped by the lubricant. It is very interesting that with .003 in. total clearance, the bearing housing moved less than .001 in. at 2750 r.p.m. with 500 lb. load. If the oil is suddenly cut off, there is an interval of perhaps a quarter minute before the oil will be sufficiently squeezed out to cause sticky operation. This merely means that successful operation depends on the proper combination of load, area, speed of load rotation and that the oil be continuously replenished in the clearance space.

Theory of Squeeze Film Applied to Rotating Load Bearings

From the results, the idea is developed to explain why a bearing with rotating load has been thought to run on a thinner minimum oil film than a steady load bearing, in the ratio of one to two or three. It is proposed that the allowable minimum film is essentially the same in both cases. The difference is due to the dual-formation of the oil film in a rotating journal from these two actions. The rotating *journal* builds up its film according to the classical hydrodynamic method of ZN/P, etc. Secondly, a "squeezable" film is built up by the rotating *load*. The combination of these two effects gives the improved oil film. The relative importance of these two films varies with many factors, as shown in the Appendix. The squeeze film differs radically from the hydrodynamic film in that a minute amount of heat is evolved in the former, whereas the classical film is formed by shearing the oil, thereby always producing heat.

In the case of a four-stroke cycle piston pin where the load reverses, the effect of the "rotating motion" is small and the effect of the "squeeze motion" is large. On a two-stroke cycle piston pin where the load usually is uni-directional the effect of the "squeeze motion" may be zero, and only the rotating motion is usable. The "squeeze" film is always established, whatever the load, speed, etc., if there is a change in load direction to "fresh" surfaces and if the oil is replaced in the clearance space, although the conditions of surface finish, etc., may cause a final break-through. The hydrodynamic oil film is established *only* if the load, speed, viscosity, etc., are above the critical value.

To investigate the possibility of the squeeze film being attained in an actual connecting rod bearing, a specific application is treated in the Appendix. It is shown that an effective squeeze film on the order of .0005 in. may be formed in a 2¾ in. by 1⅜-in. bearing running at 3000 r.p.m. with a load of 4000 lb. and SAE-50 oil at 210 F.

Thus it is concluded to be possible to support a load on an oil film produced between two flat parallel bearing surfaces, in contrast with the usual concept, provided there is a rotating or alternating load. And such bearings do comprise a large percentage of our supports in engineering. The most severe duty of all bear-

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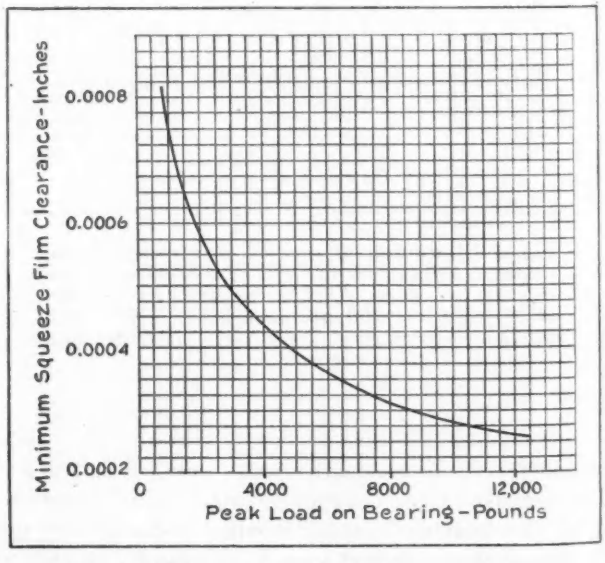

Fig. 5—Effect of peak load on minimum squeeze film clearance. Conditions same as Fig. 3.

PROSPECTIVE EXPANSION of AIRLINE ROUTES

and Services in the United States

By W. A. Patterson

President, United Air Lines

AT THE present time, the domestic airlines hold certificates of convenience and necessity permitting them to give passenger, mail and express service to 314 cities in the country, and applications are on file with the Civil Aeronautics Board requesting the privilege of serving a grand total of almost 5000 cities, towns and villages. Applications are on file proposing service on routes of a combined total of well over half-a-million miles, as compared to the present 63,000 miles.

The cities which are now certificated airline stops represent the great bulk of the urban population of this country. All cities of over a quarter of a million population, 84 per cent of all cities over 100,000 and 44 per cent of all cities over 25,000, have direct air service today.

In terms of the total population of the nation, about 32 per cent of the people live in cities which are on the airline map. This ideal description of each area served would be based not on political unit or linear distance, but on "time" distance, including all points from which the airport could be reached by ordinary means of transportation within perhaps 45 minutes or an hour. To determine such a boundary for each certificated point is obviously a task too complicated and time-consuming to be undertaken, but a method has been used which offers a reasonable approximation to the information desired. This involves the use of the 25-mile radius, 25 miles being accepted as the equivalent of one hour's drive under ordinary traffic conditions to or from the airport. The evidence indicates that much airline traffic is drawn from even greater distances, but we use 25 miles as representing a standard of normal convenience. Using this method, the Economic Bureau of the Civil Aeronautics Board discovered that the population served by airline stops is actually 60 per cent of the United States total population.

By August, 1943, there were on file with the Civil Aeronautics Board 233 applications for domestic service to 3100 points in addition to those already served, and these applications represented an estimated 300,000 additional route miles. Six months later, the number of domestic applications had increased to 542 requesting approximately 4500 points and an estimated total of over 500,000 route miles. Early in 1945 there were 613 applications pending. Of this total 404 were for conventional airline service, 82 for helicopter routes, 56 for property pick-up service and 81 for non-scheduled service. In variety of service offered the applications ranged from customary trunk-line service to the transportation of liquids in bulk, from city taxi service to the operation of "an hourly elevator service to the bottom of the Grand Canyon."

The first development which can reasonably be expected in the changing trunk-line pattern service is the addition of points to existing routes and thus an increase in the total number of places accessible by air.

A second current development in trunk-line service is the integration and modification of existing systems to permit flexibility in service. One example of this was the Civil Aeronautics Board's approval in March of the consolidation of two of American Airlines' routes with a segment of a third, the principal purpose of the consolidation being to permit non-stop operations between route terminals and various intermediate points which previously could not be given non-stop service.

The increase in non-stop operations may lead in effect to the superimposition upon the present air network of a second route pattern with considerable xariation from that now established. Something of the kind has already occurred on the New York-Chicago route. United Air Lines, American Airlines and Transcontinental & Western Air are certificated to operate between those terminals by three different sets of intermediate points, but each also offers a non-stop service, and for this operation American and TWA are authorized to use the same airway as United. With the development of larger aircraft, non-stop operation over the longer, even the transcontinental routes, becomes feasible; and it has been suggested that a system of airways following the great circle routes should be provided for them.

The universal demand for through service has led to

This article presents excerpts from the paper of the same title by Mr. Patterson presented recently at the Chicago Forum on Aviation under the auspices of the Chicago Association of Commerce and the University of Chicago.

the entry of the various airlines into major traffic centers or gateways which they had not previously served, and the authorization of duplicating operations on extensive portions of the existing system of air routes. For example, the New York-Boston route, long served by a single carrier, is now operated by three airlines. The same is true of the Los Angeles-San Francisco route, and the Chicago-Detroit route which are now served by three airlines. Chicago-New York traffic, which has had three-carrier service, will be served by four airlines in the future, and Detroit-New York traffic, formerly served by only one line, will also have four-carrier service in the near future. The number of carriers coming into such major centers as Chicago, New York, Detroit, and St. Louis has recently been increased by action of the regulatory body.

Still another means which we may expect to see employed to further the integration of our air route pattern, and one for which there is a greater background of precedent, is that of merger of existing domestic systems. Merger, consolidation and acquisition are permitted under the Civil Aeronautics Act, subject of course to the usual consideration of the public interest, and have been encouraged by statements and decisions of the Board.

Dependability of Service

In addition to these developments relative to the trunk-line network itself, we may look forward to certain improvements in the character of airline services which the airlines will offer. One very important respect in which improvements can be expected is regularity and dependability of service. Dependence upon favorable weather conditions has always been a serious problem in airline operation. Some weather factors will always affect flight, and for that reason we may expect that airline schedules will remain to some extent more fallible than those of surface transportation, but the war-accelerated development of traffic control methods and radio aids to navigation promises a very substantial improvement over past operations. As to traffic control, there have been some estimates that, given the new equipment and sufficient parallel runways, a well-planned and well-operated airport might handle as high as 150 aircraft operations per hour, or 10 times the New York airport volume in 1941, even under instrument conditions. A recent report on Air Transport Command operations predicts that the use of equipment and procedure which it has tested in scheduled operations could reduce cancellations by 90 per cent. Army flight operations are, of course, not carried on with the same safety standards which commercial airlines follow for the protection of their passengers, but even a smaller degree of improvement would bring very near to perfect the operation record set by the airlines in the past year when they completed all but 6 per cent of flight miles scheduled.

A recent survey showed that 84 per cent of those replying said they had no preference as to the size of the planes in which they flew, but 80 per cent of the same group said they would prefer an inconveniently located airport with frequent schedules to one nearby with but few schedules.

The transcontinental record of 6 hours and 4 minutes set by the C-97 recently will not be matched immediately in commercial airline operations. There will be, however, impressive reductions in schedule time. United expects, with the arrival of DC-6 equipment, to offer New York-San Francisco service with two stops in 10 hours 14 minutes, and one-stop schedules of only 9 hours 24 minutes.

Extra-Fare Services

Air service up to the present has been a one-class, one-rate service. One might cite the extra-fare sleeper planes in operation before the war as a refutation of this statement, but the added charge in this case was actually for a single definite service rather than a different class of accommodation. Space limitations at present preclude the establishment of different classes of service on the same plane, but the expected increase in schedule frequency and in variety of equipment available may lead to more differentiation than in the past.

TWA is now returning four-engined airplanes to its transcontinental operation as an extra-fare service, and some two-thirds of the replies to one survey indicated the customer's willingness to pay a surcharge for added speed.

A coach-type, "sit-up" service, to be operated in conjunction with sleeper accommodations, is one of Pan American's proposals for the South American service. The same idea might be applied by the domestic lines; however, in view of advances in speed which will permit a transcontinental trip in the short space of 9 hours 24 minutes, there is some question whether the demand for sleeper service will be maintained.

Local and Feeder-Line Routes and Service

Perhaps no phase of expansion of the domestic airline route pattern has generated more widespread interest over the past two years, and presented more problems, than proposals to bring scheduled air service to small cities and towns. These proposals envision a vast network of routes providing local air service between small communities, and connecting them with trade centers, or acting as feeder lines making connections with trunk airlines at cities now certificated.

Applications have been received by the Civil Aeronautics Board for routes designed to give local air service to over 4000 small communities. These applications vary by type of aircraft which the applicant proposes to use, by the type of cargo which would be transported and by the type of route pattern proposed. The majority propose to use conventional fixed-wing airplanes, landing at cities spaced relatively close together on the projected route, and carrying passengers, mail and express. Many of these routes are designed to serve a given trade area, tying outlying towns into a trade center over routes fanning out from that center in a clover-leaf design. Others would connect cities now served by the airlines, feeding the traffic from the intermediate small cities into the trunk routes at feederline terminals.

Similar to applications in this category, but pro-

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HOW Synthetic Rubber Parts Improve Mechanical Devices

By John A. Tallant
Manager, Technical Data Service,
Hycar Chemical Co.

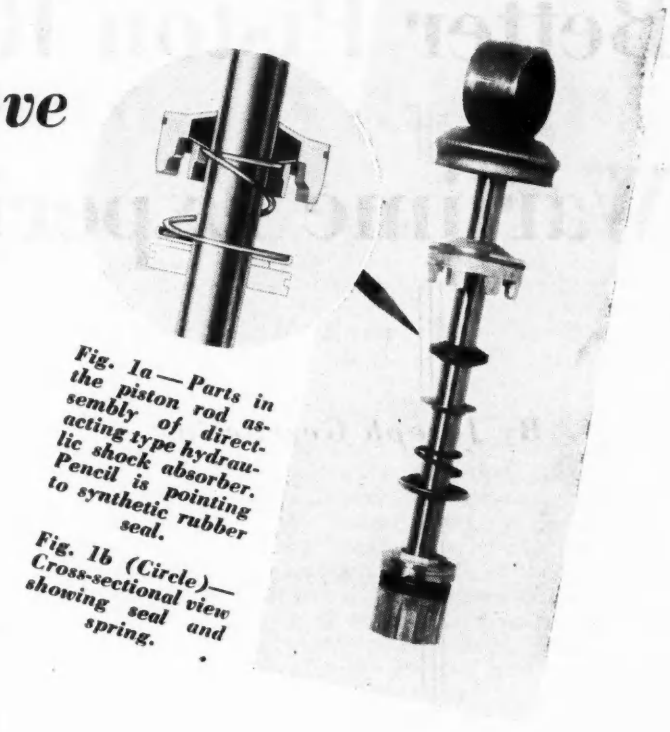

Fig. 1a — Parts in the piston rod assembly of direct-acting type hydraulic shock absorber. Pencil is pointing to synthetic rubber seal.

Fig. 1b (Circle) — Cross-sectional view showing seal and spring.

BECOMING increasingly prevalent are notable examples of how synthetic rubber, because of its versatility and unique properties, has made possible the design of more efficient and more dependable mechanical devices, with lower over-all manufacturing costs. Three such examples are found in a shock absorber for Jeeps, an automatic pilot for aircraft and an automotive water pump, all of which depend for their successful performance on the perfect operation of a rubber part. The finished rubber parts for these devices are being made by the Ohio Rubber Co. from oil-resistant synthetic rubber manufactured by Hycar Chemical Co.

The complete shock absorber is made by the Gabriel Co. for approximately half of the Jeeps produced as well as for many other vehicles. It is of the direct-acting type, rather than the lever type, and thus can be of lighter construction than the low-pressure units. The unit consists of an outside protective cover cylinder, an intermediate cylinder which is the reservoir for the hydraulic fluid, a light oil; and the inner cylinder, housing the piston rod assembly shown in Fig. 1a. As the shock absorber is compressed, the hydraulic fluid flows upward through the orifices in the piston and with extension, the flow is reversed. It is the resistance to flow through the orifices that damps the impact on the springs to which the shock absorber is attached.

The small synthetic rubber seal pointed out in Fig. 1a fits snugly around the piston rod at the position indicated in the illustration. It must be highly oil resistant to maintain dimensional stability, as it must form a perfect seal at all times, otherwise the shock absorber's entire principle of operation would fail. A natural rubber seal would not serve because the oil fluid would quickly destroy it. Nor would a leather seal serve because it does not have the resiliency to form a constant seal and also has a tendency to leak. Some synthetic rubbers would not be satisfactory because the seal must neither shrink nor swell, which, if it occurred, would result in binding as the rod moves. Also, the seal must resist the high temperatures created by the motion of the piston rod, which makes approximately 100 strokes a minute during normal driving. This motion of the rod also has a tendency to wear down the seal, so good abrasion resistance of the seal also is a requisite. A spring (see Fig. 1b) pushes the seal into

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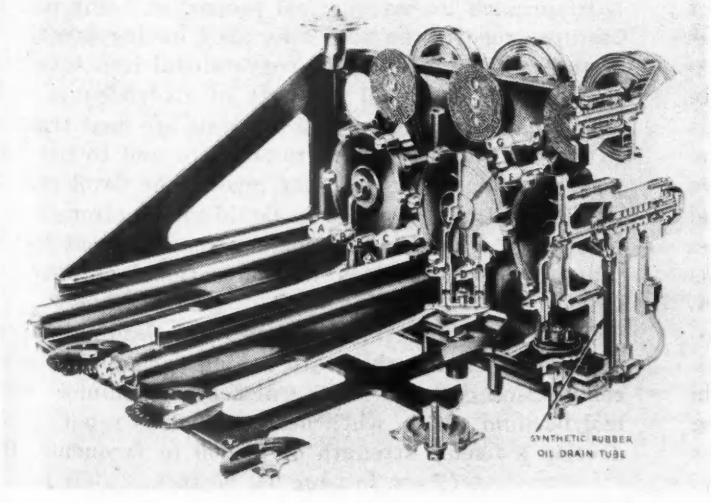

Fig. 2—Sectional view of airplane automatic pilot. Arrow indicates where elbow-shaped drain tube of oil-resistant synthetic rubber is installed.

Better Piston Rings *from* Wartime Experience

By Joseph Geschelin

BEYOND question, the experience gained in wartime production of piston rings will exert a marked influence upon the character of the product which will be offered to engine designers in postwar days. Life and performance of engines for passenger cars, trucks, buses, tractors, and for marine use will be improved immeasurably thereby. According to many observers, the extraordinary performance of piston rings in military aircraft engines and in motor transport engines operating in desert country reflects the summation of improvements which might normally stem from 10 to 20 years of peacetime progress.

Only two years ago, during the African campaign, piston rings in military aircraft engines were wearing out in as little as 10 hours while engines in ground vehicles lasted less than 3000 miles. These were not shortcomings of the rings themselves. Mortality was due to hitherto unexperienced service conditions aggravated by severe military operation, lack of adequate maintenance, and unusual climatic conditions. At this writing the extent of progress may be gaged from the fact that aircraft engine piston rings now are good for over 1000 hours of operation under normal conditions as compared with 350 hours accepted heretofore; while Diesel-electric locomotive ring life has been boosted from 50,000 miles to over 250,000 miles. The 100,000-mile automotive ring combination appears close to realization, according to one specialist.

Despite the practical know-how of the specialists in this field, despite the extensive research work being done by them, there is no simple or exact formula for fitting a ring to an engine design. Each engine and each application of the same engine must be studied as a special problem if optimum results are to be obtained. Certain features of engine design have an influence upon the selection of the best ring combination. For example, if cylinders are plated with porous chromium, satisfactory oil control usually requires higher unit loading of oil control rings than conventional practice.

Two-stroke cycle engines demand treatment different from that for four-stroke cycle engines. Ring combinations suitable for new engines must be modified in order to give satisfactory results if installed in the same engines after the cylinders are worn tapered and out-of-round. Such factors as engine size, speed, output, grade of lubricant, and many others, all exert an influence upon the selection of the ultimate ring setup.

Progressive improvement in the art results from many avenues of activity. It has come from advancements in metallurgy, surface treatments, surface finish, machine shop practice and quality control.

Piston rings of gray cast iron have been the accepted practice from the beginnings of the industry. Over the years, however, refinements in foundry practice—in melting and molding—have resulted in the production of an exceptionally fine grade of cast iron with a tensile strength upwards of 50,000 psi. The castings thus produced have a fine grain structure with a uniform distribution of graphite, to the exclusion of ferrite or pure iron.

More recently, particularly during the war, certain applications demanded the use of alloy cast iron possessing much higher physical properties. One manufacturer reports the use of an alloy having practically the same analysis as its conventional iron save for the addition of small amounts of molybdenum and chromium. Castings of this analysis are heat treated to develop the desired microstructure and to provide good machinability. Another reports the development of a special alloy for use in liquid-cooled aircraft engine rings which has a tensile strength about twice that of the material in its conventional automotive rings.

Two special materials developed by a leading maker of aircraft engine rings are a high carbon cast iron composition alloyed with nickel, chromium, and molybdenum which, when heat treated, is reported to develop a tensile strength of 65,000 to frequently in

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The Place of the

Gas Turbine in Aviation

By Charles D. Flagle

Design Engineer
Aviation Gas Turbine Division

and Frank W. Godsey, Jr.

Manager, New Products Division
Westinghouse Electric Corp.

THROUGHOUT its history, aviation progress has been paced by the development of airplane engines. The constant trend has been toward bigger and faster airplanes, consequently toward more powerful engines. Until recently, airplanes were driven only by reciprocating internal combustion engines. Now there are new power plants and of them, two will undoubtedly figure largely in aviation of the near future. One of them is the jet propulsion engine; the other is the gas turbine-propeller drive. Both will have continuous combustion gas turbine as the prime mover.

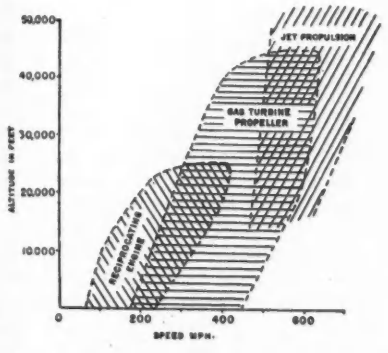


Fig. 1—Probable fields of use of the three types of aircraft power plants of the near future.

The use of gas turbines in aircraft will eventually result in new design concepts for air transportation; and comparisons of the new turbine power plants with conventional engines should properly be made on the basis of finished airplanes designed to best fit the characteristics of their particular power plants. Test stand fuel consumption rates are a good measuring stick between engines of similar types, but should not be used as a primary figure of merit in comparing different engine types. The size, weight and cooling requirements of an engine, together with its efficiency in converting fuel energy into thrust horsepower and the ease with which it is installed in clean, low drag airframes determine its real economy.

While the reciprocating engine will undoubtedly continue to hold its present position in the field of low power and for planes of low speed, the gas turbine will come into its own both as a jet engine and for driving propellers in high powered planes and for high speed flight.

Of the three types of power plants, the gas turbine-propeller engine has characteristics that give it superiority over the reciprocating engine in all speed ranges and over the jet engine in low and intermediate speeds. The jet is pre-eminent in the highest speed range. Fig. 1 shows the probable fields of use of the three types. These conclusions are reached by comparing the performances of airplanes in which each of the three types of engines might be installed. Before proceeding with this comparison, however, it would be well to discuss the engines by themselves; to describe the properties of the new gas turbine engines, and to review the status of the conventional engine.

The Reciprocating Engine

The development of the modern reciprocating aircraft engine is one of the great technical achievements of our age, inspired to no small degree by military requirements. That the primary objectives of efficiency, light weight, and reliability have been met need hardly be repeated here. However, power ratings have reached a point where further major increases can probably only be attained by improvements in fuels or the addition of cylinders. The diameter or frontal area of engines is already limited by allowable piston speeds, larger engines are longer engines, and the specific weight is more apt to increase with power rating than decrease.

Unfortunately, reciprocating engines capable of delivering several thousand horsepower require controls, accessories and exhaust disposal systems which complicate installation and maintenance problems to an extent that limits further large increases in power rating. Fig. 2 illustrates the probable trend in future specific weights for large engines.

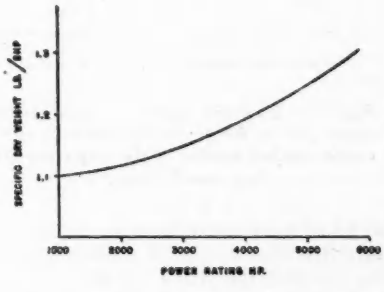


Fig. 2—Predicted specific weights of conventional engines. (from "Aircraft Power Plant — Past and Future" by Sir A. H. Roy Fedden.)

The reciprocating engine is by nature adapted to cruising flight rather than sustained high speed flight. Its highest efficiency and greatest reliability are achieved only when the engine is operated below 60 per cent of rated power. An underpowered airplane is constantly plagued by power plant troubles of a mechanical nature. Fig. 3 shows some typical fuel rates at various operating conditions.

The Gas Turbine-Jet Engine

Jet propulsion of aircraft has recently become a subject of much pub-

IMMEDIATELY after Pearl Harbor the Bureau of Aeronautics, U. S. Navy, contracted with the Westinghouse Electric & Mfg. Co. (now Westinghouse Electric Corp.) to develop the axial flow type of gas turbine as a power plant for aircraft propulsion. That this project has reached a successful stage is indicated by the announcement that Westinghouse recently organized an Aviation Gas Turbine Division to manufacture this type of prime mover. United Aircraft Corp. also reports that its engine division, Pratt & Whitney, will build Westinghouse gas turbine engines. In this article two Westinghouse engineers present their appraisal of the axial flow gas turbine as an aircraft power plant and where its application will prove most beneficial.

licity and confusion. In jet propulsion, all the power output of the engine is used to accelerate the air taken into the engine to a jet of approximately acoustic velocity which is expelled through an exhaust nozzle. The resultant thrust felt by the engine housing is the reaction to the force required to accelerate the intake air to its exhaust velocity. (Rockets also work by accelerating their internal charge to a high velocity, but they carry their own oxygen and fuel making them independent of the atmosphere.) The gas turbine operates by inducting air, compressing it, adding heat at high pressure, and expanding the high temperature combustion products. The major part of the energy is recovered in expansion through the turbine blading and must be used to supply energy required for compression. The remainder of the expansion can be made to take place through a nozzle, where the energy appears as kinetic energy of the exhaust gases.

One may ask why the gas turbine

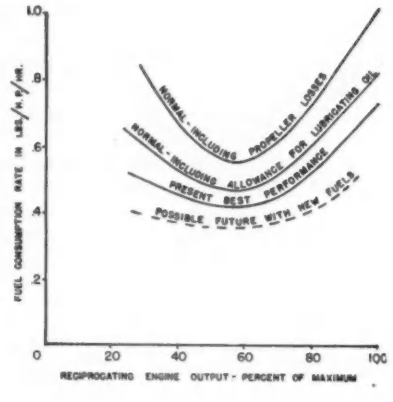


Fig. 3—Typical fuel consumption rates for a large reciprocating aircraft engine under different operating conditions.

can be so well adapted to jet propulsion while the conventional engine cannot. The answer lies to a great extent in the fact that the gas turbine handles a much greater mass of air (four to eight times greater than the reciprocating engine for each pound of fuel burned) which leads to a more efficient jet reaction. The difference here is that the reciprocating engine requires a large mass flow of air for cooling external to the combustion space, while the gas turbine swallows it own cooling air and subjects it to the same thermodynamic cycle as the air needed just to burn the fuel. The relatively high combustion temperatures of the reciprocating engine results in high speed exhaust gases with very unfavorable velocity ratios for jet flight at subsonic speeds.

Fig. 4 shows an axial flow type jet engine, in which the compressor, combustion chamber and turbine are arranged in line so as to present the minimum frontal area. Some jet engines have been built using centrifugal compressors, giving a machine of larger diameter. Principal advantages

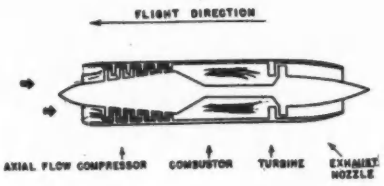


Fig. 4 — Schematic illustration of an aircraft jet propulsion engine with axial flow compressor and in-line combustor and turbine.

of the jet engine are its simplicity and light weight. The installed weight of the jet propulsion engine is little higher than its dry weight, since little oil is required for lubrication, and the engine itself requires no external cooling provisions.

The jet engine's thrust is relatively constant over normal airplane speed ranges. Therefore, the rating of a jet engine is usually given in terms of thrust rather than hp and means nothing from a power standpoint until the speed is also given. A thrust of 1 pound at a speed of 375 mph is equivalent to 1 hp; at lower speeds the power rating decreases and at higher speeds it increases in direct proportion.

An adjustable pitch propeller is capable of converting shaft power into thrust hp rather efficiently over a wide range of airplane speeds, but the jet's efficiency is quite low at low speeds. This is shown in Fig. 5, in which it can be seen that present jet efficiency does not equal propeller efficiency until flight speeds of about 500 mph are attained. Below this speed the jet efficiency, consequently its fuel economy, is inferior. The fuel efficiency of a jet engine is low, principally because of the jet efficiency characteristic; secondly, because the gas turbine itself operating at a low compression ratio is handicapped in efficiency. At 375 mph, the apparent or test stand propulsive efficiency of a jet engine will be less than half that of the conventional power plant. Its take-off thrust will be ¼ of that of a propeller with the same power rating at 375 mph, Fig. 6. Jet propulsion gives excellent high speed performance at the expense of range and low speed characteristics.

It is significant to note that jet efficiency overtakes propeller efficiency in a speed range in which compressibility effects impose critical aircraft design limitations. Much aerodynamic research must be carried out before jet propulsion can be utilized to its best advantage.

The Gas Turbine-Propeller Drive

A simple open cycle gas turbine can be built today to work at a peak temperature (temperature of gases entering the turbine) of 1500 F. With further metallurgical progress, the life of highly stressed turbine parts operating under high temperature will be increased and the limiting cycle temperature may be elevated above 1500 F. With a compression ratio of 10 to 1 and compressor and turbine efficiencies of 85 per cent a fuel efficiency of 26 per cent can be achieved. By increasing compressor efficiency to 87 per cent and turbine efficiency to 89 per cent we may expect a rise in efficiency to 28 per cent at standard sea level conditions. At 15,000 ft, due to low ambient temperatures, the cycle efficiency rises to 3.15 per cent.

A schematic illustration of a gas turbine geared to a propeller is shown in Fig. 7. In appearance, the axial flow gas turbine for propeller drive will be a symmetrical machine, its reduction gear concentric with its rotor. Its diameter will be less than half that of a conventional engine of comparable power, permitting it to be easily buried within a fuselage or wing. Presenting little frontal area and requiring no external cooling air for itself, the gas turbine offers very little drag at high speeds. This, in addition to the fact that the gas turbine efficiency is best at its peak load, points to the adaptability of this type of power plant to high speed flight.

The efficiency of a gas turbine is highest at its rated load and rated rpm. As rpm decreases, the efficiencies of compression and expansion drop off and the compression ratio also decreases rapidly. Since the useful power output of the machine is the relatively small difference between the power developed by the turbine and power absorbed by the compressor, any change in compressor or turbine efficiency is magnified in its effect on power output. In fact, it is doubtful if the turbine output will be sufficient to drive the compressor—much less supply power to the propeller at much below ½ rated speed. Idling speed for a gas turbine propeller drive will be between ½ and 2/3, the rated rpm.

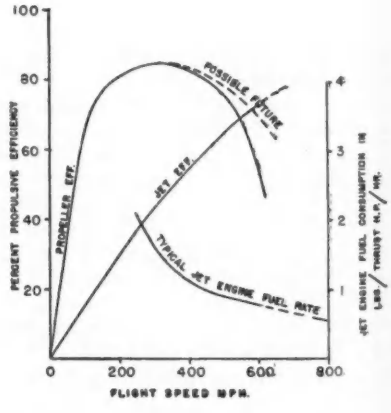


Fig. 5 — Propulsive efficiencies of propellers and jets of jet engines. The fuel consumption of a typical jet engine is also shown.

The gas turbine for propeller drive operates on four to eight times the quantity of air used by a reciprocating engine of comparable power. A large exhaust jet thrust is available to supplement the propeller, since normally about 20 per cent of the useful power

remains in the exhaust gases as kinetic energy; the proportion of useful power remaining in the exhaust to power delivered to the propeller can be controlled by the designer. The gas turbine will permit a much lighter power plant installation than will the reciprocating engine. The installed weight of the geared gas turbine engine should be less than ¾ the weight of the equivalent reciprocating engine installation.

In general, operations at normal flight altitudes are favorable to economical turbine performance; fuel rates are indicated in Fig. 8. It is interesting to note that for rough approximation purposes, the exhaust jet thrust just about compensates for propeller losses and nacelle and cooling drag, so that the shaft power output of the turbine is just about equal to the

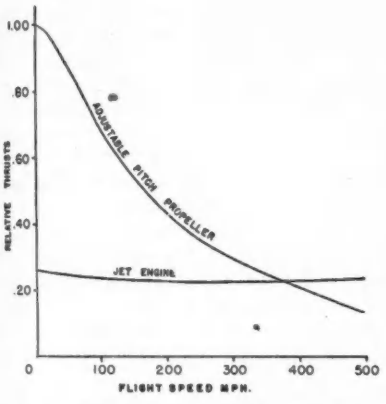


Fig. 6—Relative propeller and jet power at 375 mph, at different engine thrusts with equal thrust flight speeds.

net thrust horsepower available. This is very different from the reciprocating engine as will be shown later.

The gas turbine is not a supercharged engine. Therefore, the selection of power rating must be based on altitude requirements; and for sea level operation, considerable excess power will usually be available. Typical power availability curves for various types of power plants are shown in Fig. 9.

The Airplane And The Reciprocating Engine

The foregoing portions of this article have described the principal features and characteristics of conventional reciprocating engines, gas turbines geared to propellers, and jet engines. How they are now used and how they can best be applied to aircraft in general will be considered in the following material.

The reciprocating engine, in its normal cruising power range, is a very efficient means of converting fuel energy into shaft power. However, its application to aircraft is complicated by many difficult problems, among which are the necessity for supercharging at high altitudes, severe vibration, excessive weight installed as compared with dry engine weight, and high nacelle drag and engine cooling power losses.

For medium range and long range aircraft, the most important problems are probably the reduction of nacelle drag and engine cooling losses. Airplanes designed for low speed operations can afford to have a large part of the plane's parasitic drag absorbed in engine nacelle and engine cooling losses, since induced drag may be a large portion of the total flight power requirement and engine losses are a relatively minor factor. This is distinctly not the case with long range and high speed aircraft where induced drag is relatively small and parasitic drag all-important.

The reciprocating engine presents a dismayingly large fontal area when placed in a wing nacelle, and the total profile area of power plant frequently exceeds that of the fuselage. Similarly, the reciprocating engine requires large volumes of cooling air that must be forced around the cylinders of air-cooled engines or through the radiators of liquid cooled engines as well as through numerous accessories and oil coolers. Figs. 10 and 11 show the power losses at different airplane speeds for a typical 2000 hp engine installation complete with propeller and installed in a wing nacelle. The remaining available power under any but low speed flight conditions is greatly reduced by these losses. Fig. 10 shows typical losses for maximum engine power at all speeds, and Fig. 11 shows the average losses for the same engine under flight conditions in a large airplane with a top speed of 400 mph; higher speeds would still further accentuate the losses. Also shown on Fig. 11 is a fuel rate curve based upon the net thrust hp of the power plant after all power plant losses have been accounted for; this should be compared with the excellent performance of similar engines on the basis of shaft hp output in Fig. 3.

Large reductions have been made in propeller losses in recent years, and also in nacelle and cooling drags, which

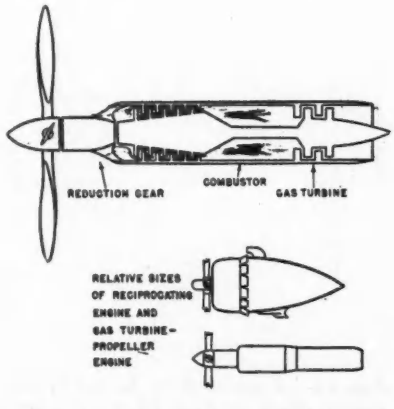


Fig. 7 — Schematic illustration of axial flow gas turbine-propeller engine.

may be attributed principally to nacelle design improvements and the use of engine cooling fans on radial engines. It is reasonable to suppose that further reductions will be made in the future, particularly for specialized applications such as high altitude, high speed flight. Until such improvements are made, high speed operations will be limited by power plant rather than airframe whenever reciprocating engines are used.

Jet Propulsion Of Aircraft

The axial flow jet engine of Fig 4 is a

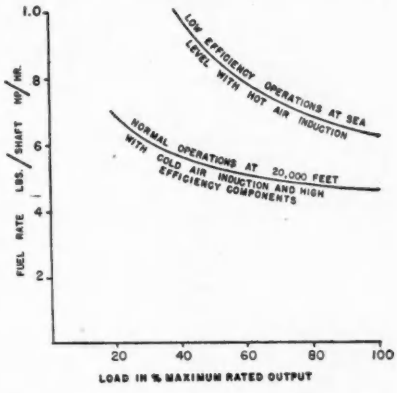


Fig. 8—Range of fuel consumption rates for aircraft gas turbines with reduction gear output to propeller shaft; rates have not been adjusted for exhaust jet thrust effects.

slender package capable of delivering slender package capable of delivering almost constant thrust at all speeds from take-off to dive maximum. Throughout this speed range, fuel is burned at practically a constant pounds per hour rate, and changes in speed have but little effect on thrust or fuel consumption. Further, the jet propulsive efficiency is approximately proportional to speed, as shown in Fig. 5. These factors will lead to the use of jet engines in high speed aircraft. At low air speeds, fuel consumption rates are exorbitant when compared with propeller driven aircraft.

To offset the disadvantage of low efficiency at low speeds, the jet engine delivers a lot of power for very low installed power plant weight in its proper flight speed range; cycle efficiency, while not good, is fair, which means low fuel cost per thrust hp at very high speeds, and the engine's diameter is small enough to permit buried installations in the wings of any but the smallest planes.

Apart from booster applications in aircraft that are underpowered with reciprocating engines, jet engines should not be installed in any but the cleanest of low drag airplanes. The most suitable applications for jet propulsion appear to lie in speed ranges where compressibility effects are the principal unknowns; supersonic problems are fairly well known from ballistics and low speed flight has been well explored, leaving at natural flight speed range of the jet engine a large

blank. It is probable that jet propulsion will serve as the tool and incentive to fill this gap in our knowledge.

To project our present designs somewhat into the future and estimate possible trends, Fig. 12 has been prepared. The solid curves represent the power required and power available characteristics of an extremely fast high altitude single seater of current reciprocating engine design; the dotted curves are for a jet propelled plane of equal gross weight and wing area but in which it is assumed that the drag has been reduced by one-half through refinements made possible by the use of

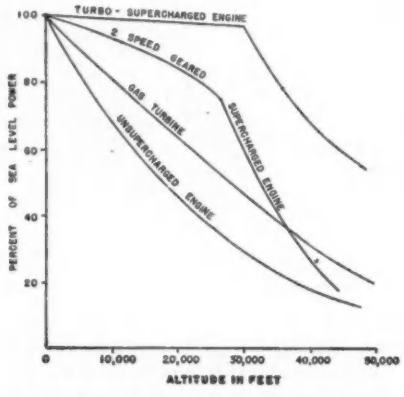


Fig. 9—Effect of altitude operations on power availability of various typical aircraft engines.

the jet engine instead of the reciprocating engine.

The maximum speed at 20,000 ft. altitude increases from 460 mph for the conventional plane to approximately 600 mph for the jet fighter, assuming that compressibility effects are absent, but the speed increase does not bring with it a better cruising radius even when proper allowance is made for the larger fuel tanks that are permitted by the lighter weight jet engine. The lowest fuel rate in pounds per mile at this altitude for the jet plane is almost double that of the conventional aircraft.

By increasing the flight altitude of the very low drag jet plane of Fig. 12 to 30,000 ft, the maximum speed may decrease slightly due to compressibility effects but the best cruising speed is increased by about 50 mph with a fuel consumption per mile about 40 per cent greater than the conventional airplane. The conventional aircraft with a high maximum speed is able to throttle back to a 270 mph cruise for maximum range. The jet plane will have to fly at over 500 ph for maximum range; and high speed always means very large power expenditures, a point often overlooked by rocket and jet enthusiasts. However, this jet plane would fly the same course in half the time that the conventional aircraft would take, and could therefore accord a reduction in range for interceptor service and related missions.

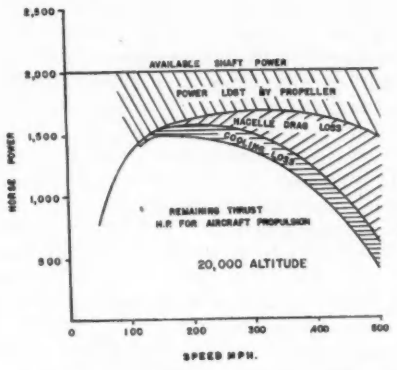


Fig. 10—Typical losses associated with a large reciprocating engine in a wing nacelle and operated at full power.

The above estimates are based upon the rather optimistic assumption of a jet plane with only one-half of the drag of the plane with a conventional power plant installation.

Fig. 13 is a bar chart comparing the relative merits of a jet fighter and a conventional fighter with regard to take-off run, rate of climb, and extreme range. The jet propelled aircraft is superior to the conventional power plant job in all particulars except take-off, climb, and range. By using a jet engine of 50 per cent to 70 per cent greater thrust than in this example, the take-off run would be reduced to about the same as the conventional fighter, the climb and ceiling would be greatly increased, and the cruising speed and maximum speed would be increased slightly, all at the expense of a heavier power plant and a further serious reduction in range.

These comparisons are also true for large aircraft such as transports and bombers, although in the case of the bomber particularly it is even more difficult to achieve really large reductions in drag because of the constant large increments of drag due to armament and navigational devices. Substantial reductions in drag can be effected, but not enough to result in jet versus piston engine fuel rates of the order indicated in Fig. 12.

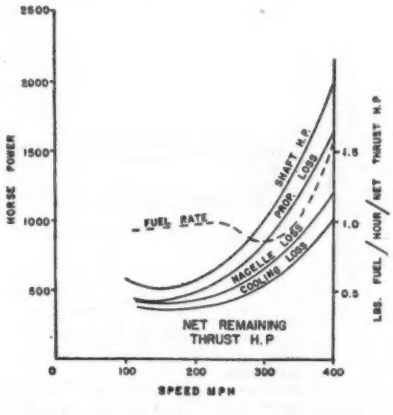


Fig. 11—Typical flight losses of the power plant of Fig. 10 when operated on the power-required curve of a large airplane designed for long range operations.

The Gas Turbine-Propeller Airplane

The gas turbine geared to a propeller, shown in Fig. 7, with typical fuel consumption rates shown in Fig. 8, has the advantages of the jet engine with respect to drag reduction and ease of installation, while at the same time retaining the high propulsive efficiency of the propeller at low speeds. The present limit of usefulness of the geared propeller turbine at high flight speeds is set by the characteristics of available propellers which lose out quite rapidly in efficiency above 500 mph. Research on propellers is necessary for several reasons, however, and propeller manufacturers are hopeful that the good efficiency range can be extended to considerably higher speeds. Something must also be done to reduce the necessity for large spinner diameters on present propellers in order to take full advantage of the small diameter gas turbine, and some weight reductions may be possible due to the absence of torsional vibration in the turbine propeller shaft. Estimates of possible propeller weight reductions vary from zero to 25 per cent from present weights. There has been considerable speculation and calculation of the advantages and disadvantages of shrouded propellers; but at the speeds now contemplated, the extra complication does not yet appear profitable.

The principal and immediate advantage of the geared propeller gas tur-

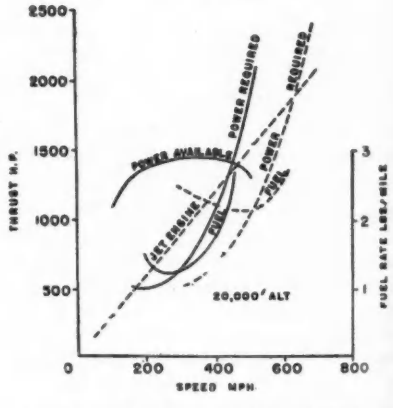
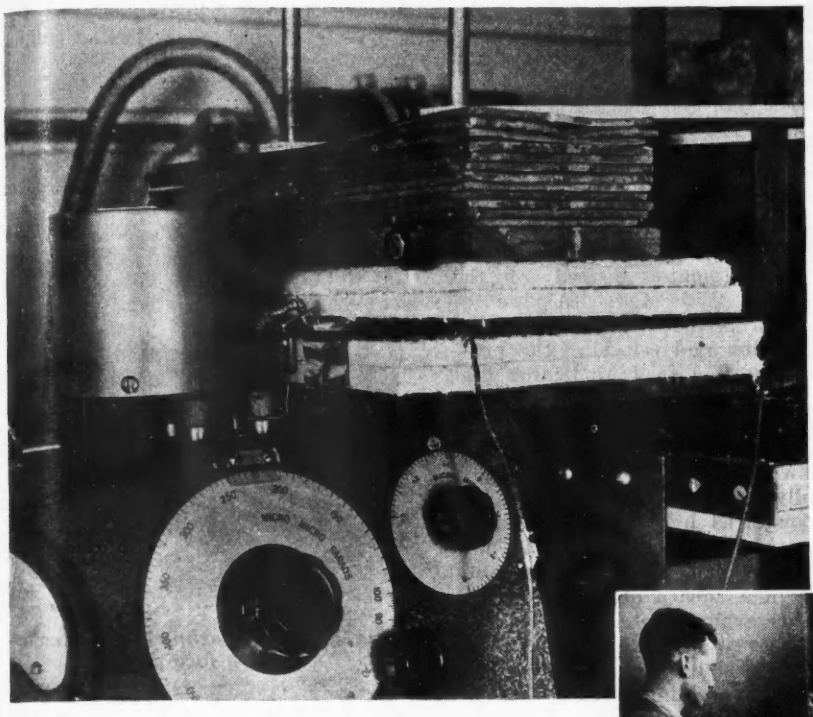


Fig. 12—Power required and power available curves for single engine airplane with reciprocating engine (solid lines) and jet engine (dotted lines). Fuel consumption rates for both aircraft are shown.

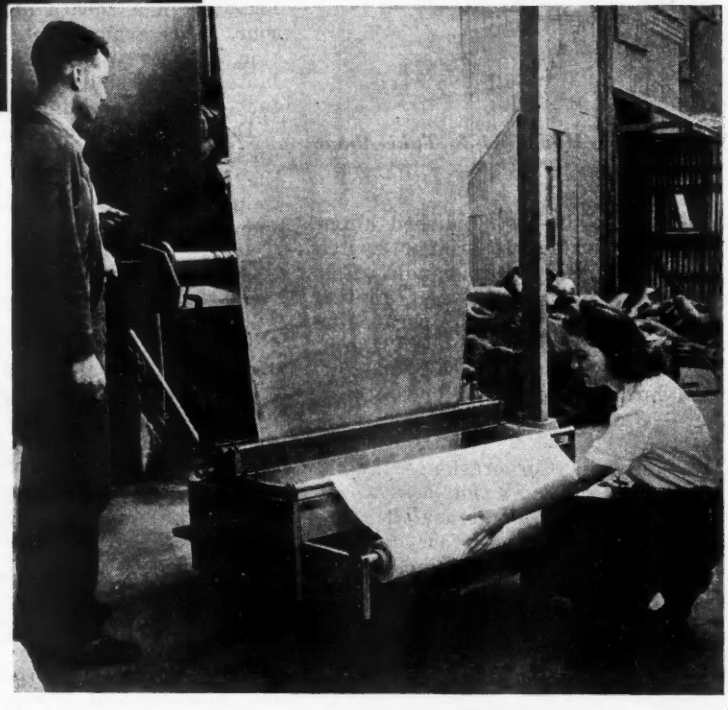
bine is a large reduction in airplane drag. Overall power plant performance for the gas turbine with geared propeller is shown in Figs. 14 and 15, which should be contrasted with Figs. 10 and 11 for the piston engine power plant. It is interesting to note that the pure thrust power obtained from the turbine exhaust is large enough to approximately offset engine nacelle drag and ordinary propeller losses under normal flight conditions. Therefore as an approximation, the shaft power output of a geared turbine of

(*Turn to page* 50, *please*)

New Plastic Laminate for Aircraft Parts



Experimentally curing Conolon laminations with high frequency heating equipment.



In making Conolon laminations, Fiberglas or Fortisan fibers must first be impregnated by passing the fabric through a thermosetting resin bath.

A NEW low-pressure plastic laminate is being used at Consolidated Vultee Corp. to fabricate certain airplane parts. It has been named Conolon and is made in three types, each of which consists of a fiber impregnated with a thermosetting resin. Type C is reinforced with high-strength cellulose fibers; type F employs extremely fine filaments of Fiberglas, and type FC is a combination of the first two types. The laminating resin used in connection with all three types has been designated N13p, and is produced by combining thermoplastic and thermosetting resins.

Both Fiberglas and Fortisan fabrics have been used as received from the mills in making Conolon laminations. However, if it should become contaminated with grease or dirt, the cloth should be thoroughly dry-cleaned with a good naphtha-type solvent before it is used.

The fibers are impregnated by passing the fabric through a bath of the N13p resin, which is usable at room temperature, and between two rubber squeegees, which remove excess resin. Then the material is air-dried for a period of 24 hr, or oven-dried for a period of 20 min at a temperature of 140 F. When it is oven-dried, the fabric should be suspended so that it will not wrinkle, sag, or be subjected to dust or moisture.

The procedure followed in laminating Conolon moldings varies in accordance with the nature of the parts to be fabricated and the stresses to which they will be subjected. The fabric fibers may be placed parallel or at an angle to one another, depending on the stresses to which the part will be subjected, and the curing may be accomplished either in a vacuum bag or in a hydraulic press at a pressure of 10 to 15 psi and a temperature of 300 F (+25 deg or —10 deg) in a period of approximately 30 min, depending on the thickness of the laminate. Good Conolon laminations are obtained by observing the following precautions:

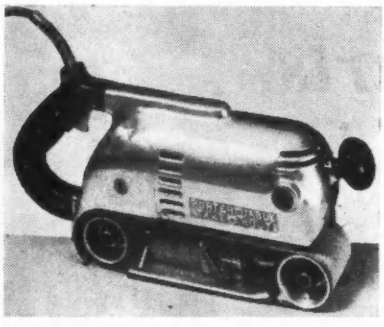
(1) The fabric must contain the correct amount of resin to produce a finished laminate containing 33 per cent (±7 per cent) solid resin for type C and 27 per cent (±7 per cent) for type F.

(2) The resin-impregnated fabric must be stored in a sealed container at a room temperature of approximately 75 F when it is not to be used immediately. In no case should the impregnated fabric be stored longer than one month or at temperatures of more than 75 F.

(*Turn to page 67, please*)

New Production Equipment

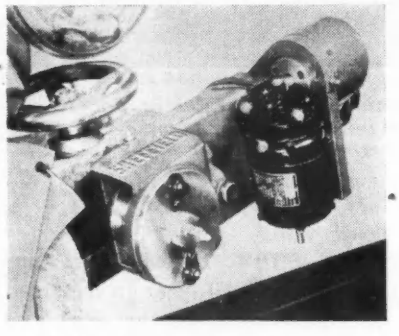
PORTER-CABLE MACHINE Co., Syracuse, N. Y., is introducing a new model Take-About surfacer, the Model A-3. Take-Abouts are portable, electric hand sanders on which endless abrasive belts operate over a flat or convex surface.



Porter-Cable Model A-3 Take-About surfacer

The frame is die-cast, polished aluminum. A quick-acting trigger switch is located in the plastic handle. Belt speed is 1600 surface feet per minute. Drive and idler pulleys operate on needle bearings, and the rubber-covered drive pulley is driven by a silent chain. The ¾-hp universal motor operates on either 115 or 220 volts.

THE Sheffield Corporation, Dayton, Ohio, has brought out a powered crush dressing device for use with the Model "B" Thompson surface grinder. It is mounted on the wheel head slide and a 1/3 hp gear-head motor is directly coupled to a grinding wheel spindle at the rear of the housing. This motor drives the wheel at crushing speed through an overrunning clutch, which is thrown out of engagement when actually grinding.



Sheffield crush dressing device

A feature of this new Sheffield device is feeding the crusher into the wheel by means of an electric motor, which turns the micrometer in-feed screw at a constant rate.

There are two styles available. Model "B" is semi-automatic with the feed dial indicator preset for a desired depth of outomatic in-feed of the crusher roll. With Model "A" the operator controls the device by pressing a push button and releasing the pressure when the feed indicator dial shows that the desired depth has been reached.

A NEW armor-clad (screw type), fully insulated electrode holder has been announced by the General Electric Company. A feature of the new holder is its head, which is completely enclosed in a sheath of aluminum armor. This armor protects the insulation, resists weld spatter, and eliminates the possibility of accidental contact with the welding circuit.

Designed to accommodate electrodes up to and including ¼ in. in diameter, the holder is easy to use, light in weight (15 oz), and unusually cool in operators.

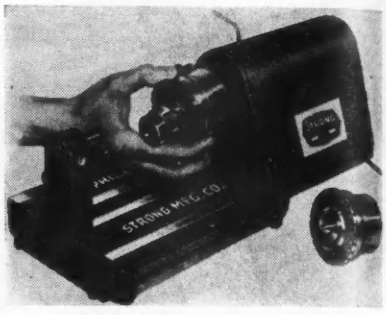
General Electric fully insulated electrode holder

operation. A twist of the hand tightens or releases the electrode. While in use, the holder firmly grips the electrode at the proper angle and good current contact is maintained.

THE Strong Multi-Purpose grinder attachment, made by the Strong Manufacturing Co., Philadelphia, Pa., is now available with a collet-holding face plate and a set of 15 precision collets.

To accommodate long rods or tubes, the tailstock center may be removed, and the long piece being worked may be extended through the attachment motor housing.

The Strong Multi-Purpose grinder attachment is equipped with a precision indexing fixture for the purpose of grinding flats, squares, hexagons, rectangles, octagons, etc. This feature is valuable for making up broaches, grinding reliefs on taps and reamers, or any similar work.

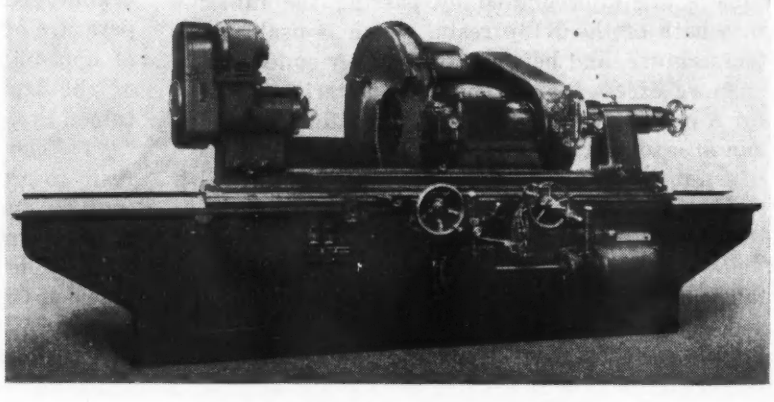


Strong grinder attachment with collet-holding face plate

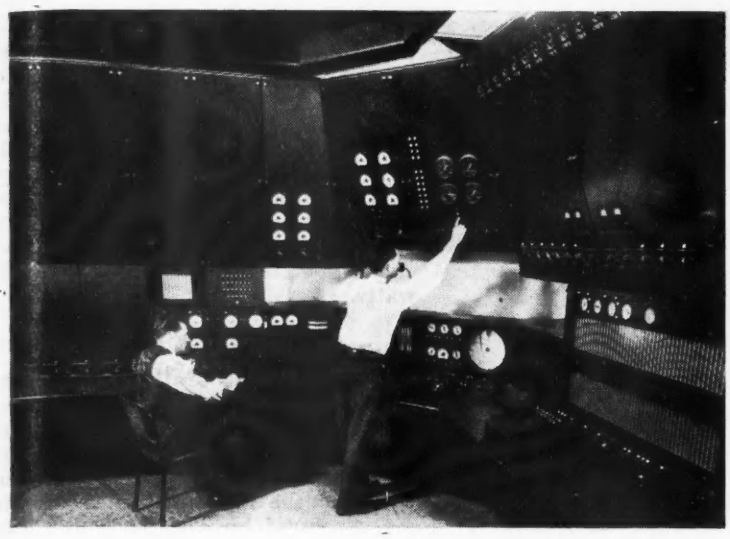
A NEW autopart and crankshaft regrinding machine in sizes of 22 by 72 in. and 24 by 84 in. is offered by Norton Company, Worcester, Mass. The machine has been designed for the regrinding of crankshaft pins and bearings on automotive, tractor, Diesel and truck shafts.

Features of the machine include headstock and footstock with antifriction spindle, with an adjustable work holder mounted on each of these spindles. These work holders have a broader range than a jaw chuck and retain their accuracy indefinitely. When grinding crankpins the shaft is held on the end main bearings. Any wear occurring in the work holders can be compensated by means of an adjustment which has been provided for in its construction.

(*Turn to page* 108, *please*)



Norton crankshaft regrinding machine

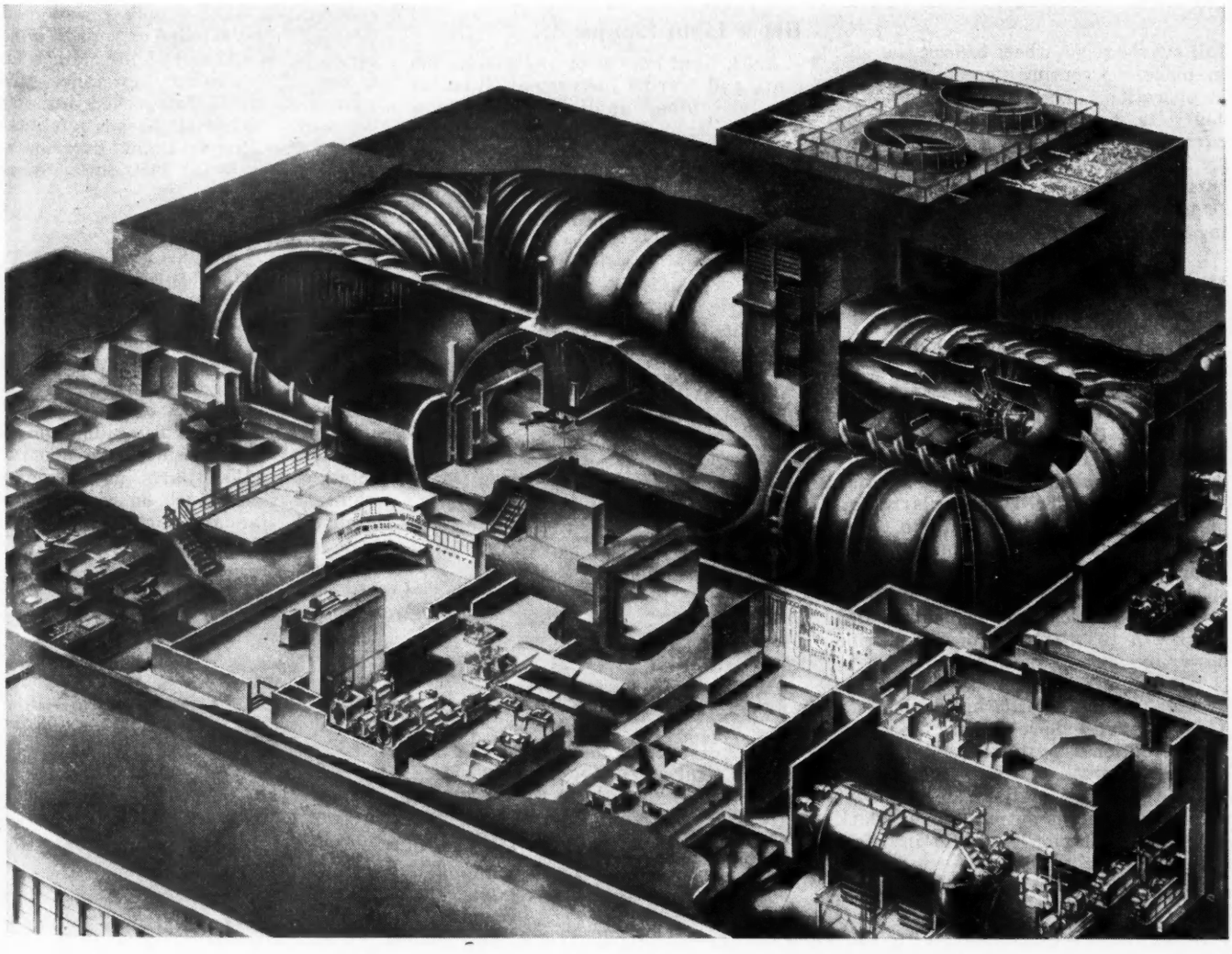


THE new $2½-million variable wind tunnel being built by the Curtiss-Wright Corp. at its Airplane Division in Buffalo, N. Y., will be capable of testing airplane models in the speed range up to 740 mph and at pressure conditions comparable to those up to 35,000 ft. altitude. The C-W tunnel is similar to the Southern California Cooperative Wind Tunnel, which was described in the May 15 issue of AUTOMOTIVE AND AVIATION INDUSTRIES. Expenses for the design of the two tunnels were shared equally by the Curtiss-Wright Corp. and the West Coast organization. The C-W tunnel is combined with the company's large research laboratory, the project costing about $4-million. The laboratory was described in AUTOMOTIVE AND AVIATION INDUSTRIES of June 15, 1943.

Shown on this page are the console and cutaway view of the tunnel. In the background of the cutaway view are the cooling towers, in the center the wind tunnel ducts and blow-off tower, and in the foreground are the model shops, control room, dynamometer room, electrical room, and altitude chamber.

Curtiss-Wright's

New Wind Tunnel



New Products for Aircraft

Starter for Large Aircraft Engines

The Kurz and Root Co., Appleton, Wis., has brought out an electro-starter for use in starting engines such as those used on B-29 planes. The electro starter is a three-wheeled, rubber-tired unit weighing about 1200 lb. that can be pulled manually or towed by a small tractor. Brakes are supplied on

Electro starter made by the Kurz and Root Co.

full swivel front wheel to lock the unit in place, preventing "creeping" while in operation. The motor has input of 440 volts, 3 phase, 60 cycle alternating current. The generator output capacity is 24-28 volts, 400-600 ampere direct current, designed especially to meet the requirements of aircraft engine starting and accessory testing.

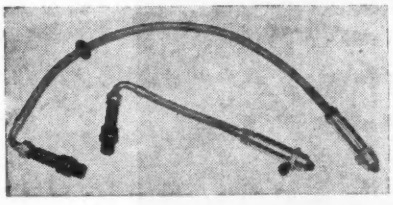
High-Frequency, Low-Voltage Ignition System

A high-frequency, low-voltage ignition system for aircraft which is said to fire spark plugs even when they are extremely fouled or dirty, has been developed by P. R. Mallory & Co., Inc., Indianapolis, Ind.

The Mallory high frequency ignition system is considered particularly important because of its ability to fire a spark plug that has become fouled, leaded, or carbonized when engine speed is reduced during the landing glide. At this critical moment, fouled plugs can rob the pilot of full engine power in case of emergency.

The high frequency system offers greater reliability at high altitudes (50,000 ft. and above) where the spark in conventional systems tends to get out of control. Other advantages claimed for the Mallory development are greater engine output, longer spark plug life, reduction in radio interference, and weight reduction.

In operation, low voltage (approximately 1200 volts) is generated in a magneto and distributed through



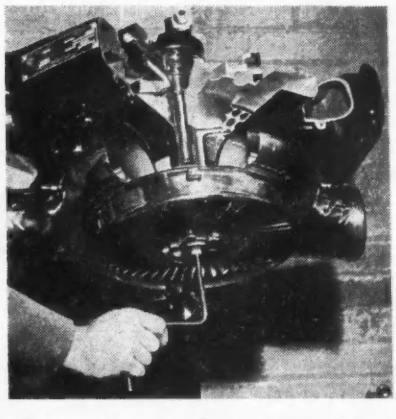
Spark plug transformer, shielded lead and frequency converter of Mallory ignition system

shielded leads to the spark plug. At the manifold ring, the low frequency energy of the magneto is converted to high frequency or radio frequency energy (2,000,000-3,000,000 cycles per second) by an impulse type of frequency converter. At the spark plug, the low tension high frequency energy is stepped up to a voltage sufficient to jump the spark plug electrodes (approximately 10,000 volts) by means of a small transformer hermetically sealed in the well of a standard aircraft spark plug.

Black Light Lamps

Black light lamps for industrial, aircraft and marine instrument illumination and other applications are now available from Sylvania Electric Products, Inc., Ipswich, Mass., for operation on 120 volt a-c and 24-28 volt d-c circuits. The near ultraviolet RP 12, rated at 4 watts, is designed for use with a visible light filter where a light-weight, compact lamp is required. It is equipped with a polarized bayonet base and may be operated in any position for use with aircraft instruments, inspection or other industrial equipment. Red-purple series tubular lamps require no visible light filter and operate with standard fluorescent lamp accessories on 120 volt a-c circuits. They are supplied with miniature bi-pin bases in five sizes ranging from the 6-in. T5 rated at 4 watts to the 36-in. T8 rated at 30 watts.

Wright Turbosupercharger

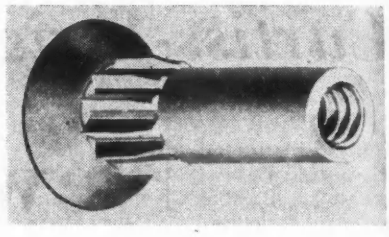


This turbosupercharger, developed by Wright Aeronautical Corp., is said to be lighter in weight and more adaptable to varying aircraft engine arrangements than other superchargers. Proposals have already been made for the installation of this equipment in new types of commercial transports and warplanes.

Splined-Type Rivnut

A new Rivnut of the splined type suitable for use in wood, plastics, leather, hard rubber or other material where it is necessary to firmly anchor a nut for attaching accessories has been added to the regular line of Rivnuts manufactured by The B. F. Goodrich Co., Akron, Ohio.

In the new type, spines beneath the



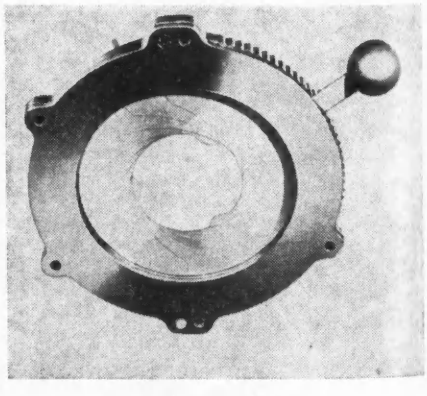
Goodrich Rivnut

countersunk head supply resistance to torque, while the bulge or "upset" which forms below the end of the splines furnishes the tension resistance. The splined Rivnut is thus locked into place two ways. Internal threads left intact within the Rivnut shank take an attachment screw for installation of accessories.

Ventilator Control Unit

A heat and ventilator control unit known as the Aero valve is announced by Smith-Mautz Co., Glendale, Cal.

The unit has 36 positive control stages, and is designed like a camera shutter, with 15 to 18 shutter segments. Its principle of assembly uses a minimum of wearing parts. Aluminum die cast cover and housing have anodized finish; all other parts are made of stainless steel. Knob on control lever is an AN standard part.



Aero valve

Man-What a Hose Clamp!

New Speed Clamp* Features

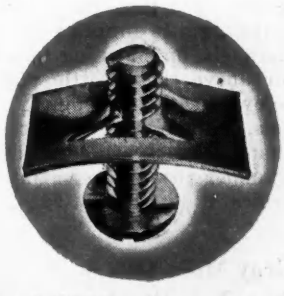
1. Exclusive, self-locking ratchet type design.
2. Lightest weight—lowest profile—sturdy spring steel construction.
3. Uniform circumferential pressure—no pinch or bind.
4. Faster and easier to install or remove.

Latch by hand | Lock with pliers | Remove with screw driver

Widely used throughout military aircraft. May be used over and over again. Sizes from ½" O.D. up. In writing for samples, please give outside diameter of hose with fitting inserted.

TINNERMAN PRODUCTS, INC.
2059 FULTON ROAD CLEVELAND 13, OHIO

In Canada: Wallace Barnes Co., Ltd., Hamilton, Ont. In England: Simmonds Aerocesseries, Ltd., London



Speed Clamps for hose connections are engineered and produced by the manufacturers of the famous SPEED NUT shown above.

*Trade Mark

Speed Nuts

PATENTED Trade Mark Reg U. S. Pat. Off.

FASTEST THING IN FASTENINGS

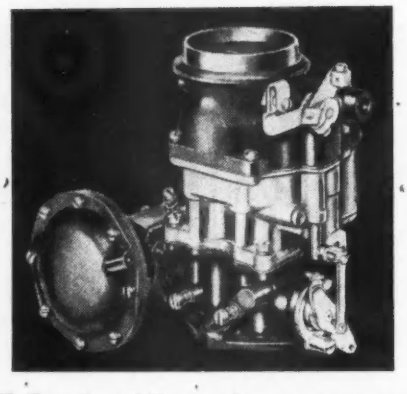
New Products

Carburetor-Governor Unit

Details of the Holley Centri-Vac carburetor-governor unit recently brought out by the Holley Carburetor Co., Detroit, Mich., have been released for publication.

The unit consists of the Holley Model AA-IG dual downdraft carburetor of the plain tube type, incorporating certain new and improved features.

The governor throttle actuated mechanism is an integral part of the unit and has been designed to provide the power required for moving the throttle to governing speeds as controlled by a separately driven governor rotor. The combination of the two units is said to have been engineered to give instant response and accurate governing.

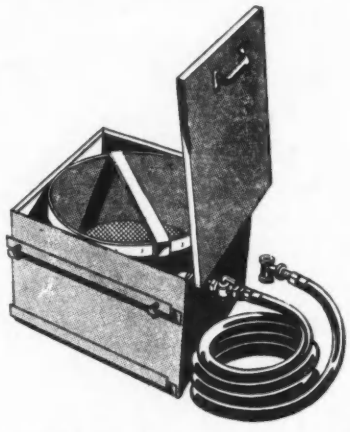


Holley Centri-Vac carburetor-governor unit

The vacuum-controlled governor mechanism, known as Model 1174, consists of two separate elements—a mechanically driven rotor mechanism, containing the governor valve and spring, which is mounted on the engine and driven from the engine by a flexible shaft; and the controls at the carburetor in combination with a diaphragm chamber. The latter, mounted as an integral part of the carburetor is connected to the governor valve air bleed orifice by a pipe line. Vacuum to the diaphragm is supplied by means of two channels, one opening into the carburetor above the throttle plate, the other below the throttle plate. These channels, in turn, are connected by another channel which leads into the diaphragm chamber through a variable restriction orifice.

Gray-Mills Offers Two New Products

Latest products of the Gray-Mills Company, Evanston, Ill., are a small parts cleaning system, known as the Model P-72, and a line of cold cleaning solvents called Agitene. The P-72 is used for removing cutting oils and lubricants used in metal working operations and for many simple cleaning operations where small parts are to be cleaned in limited quantities.



Model P-72 small parts cleaning system

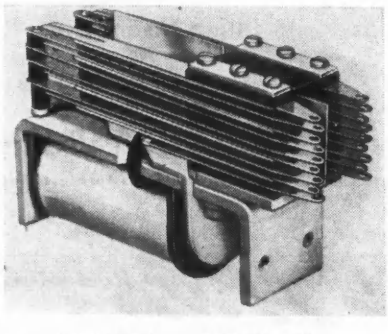
Several features of the P-72 are the time-saving Air-gitator, which provides air agitation of the (cold) solvent, Swisher basket and platform, hinged cover, air hose and "T" connection.

This unit has mounting brackets; so it can be attached to the side of the Gray-Mills larger model, the P-70 parts cleaning system, or to a wall or work bench.

Agitene (cold) cleaning solvents come in three types. Regular Agitene is for general purpose cleaning in removing cutting oils and other lubricants. Super-Agitene is a fast-acting solvent with a powerful penetrating action that quickly removes grease, tar and sludge. Speed-Agitene is used for hard accumulations, residual gums and grease deposits. It removes paint and sludge without harming metals.

Relay for Minimum Operating Currents

The long coil Type 20000 relay now being produced by R-B-M Manufacturing Co., Logansport, Ind., is especially applicable to signal, electronic and communication uses, where minimum operating currents are important factors.



R-B-M Type 20,000 relay

Contact spring assemblies of this relay can be furnished in one, two, or three stacks — with various combinations, according to circuit requirements, up to 16 springs.

Coils, specially treated to withstand extreme humidity and prevent fungus growth, are available in ranges from 1½ to 28 volts direct curent. This type of relay is also available in two-pole double-throw contact arrangement, with current sensitive coil operating at 3.2 ma pickup and 1 to 1.5 ma dropout. These relays are available with quick acting, slow dropout and slow pickup armatures.

Electronic Air Filter

Recently introduced by the American Air Filter Co., Inc., is the Electro-Mist, a self-contained, demountable electronic unit designed to collect oil mist from high speed cutting tools or welding fumes in light concentrations.

Electro-Mist air filter

An axial flow fan mounted on top of the unit draws air from the operation which is properly hooded through piping or flexible tubing into the base of the unit. In its application to cutting operations, the mist-laden air first passes through a permanent unit filter to remove any metallic dust or large drops of oil, then enters the ionizer in which the mist and smoke particles receive an electrical charge before passing into the collector unit where they are precipitated on the plates. The collected oil mist accumulates and drips off the lower edge of the plates, through the filter and into a reservoir below. As much as 2 or 3 gallons of oil can be salvaged daily and may be piped back into the machine tool or drained off as preferred.

(*Turn to page 58, please*)

HYDRAULIC BALANCE

CANCELS OUT BEARING LOADS

And Means MUCH LONGER PUMP LIFE

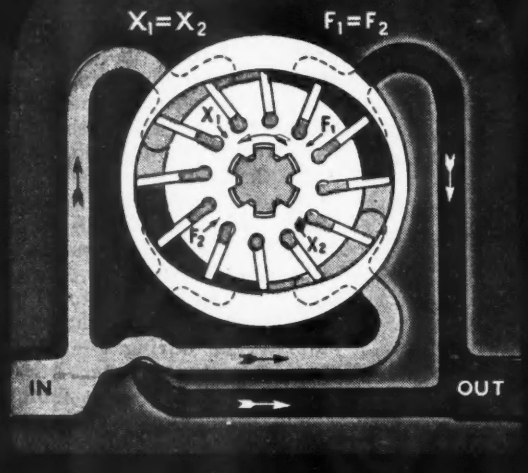
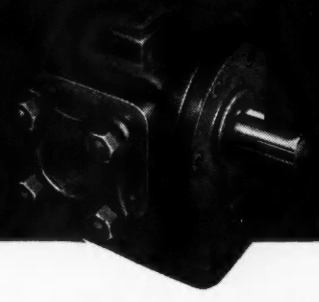


Diagram showing patented "Hydraulic Balance" construction.

VICKERS
Balanced
VANE TYPE
PUMPS



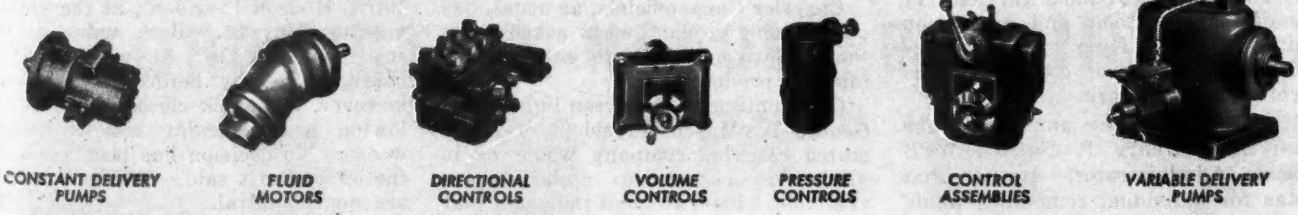
As illustrated by the diagram above, equal and opposing pressure areas are provided on the outlet side and on the inlet side of Vickers Balanced Vane Type Pumps. The equal and opposing radial hydraulic thrust loads cancel each other . . . consequently there are *no* bearing loads resulting from pressure. The major cause for wear is thus completely eliminated and the result is much longer pump life. This "Hydraulic Balance" construction is exclusive with Vickers Vane Type Pumps; it also permits an unusual design compactness and is an important reason for the exceptionally high efficiency of these pumps.

Vickers Balanced Vane Type Pumps are available in single-stage for 1000 psi (see Bulletin 40-25a); two-stage for 2000 psi (see Bulletin 40-16) and also two-pressure, large-small volume (see Bulletin 38-14). Vickers Application Engineers will gladly discuss with you the many different types of hydraulic power and control circuits on which these pumps have improved machine performance. Write the office nearest you.

VICKERS *Incorporated* • **1428 OAKMAN BLVD.** • **DETROIT 32, MICHIGAN**

Application Engineering Offices: CHICAGO · CLEVELAND · DETROIT · LOS ANGELES · NEWARK · PHILADELPHIA · ROCHESTER · ROCKFORD · TULSA · WORCESTER

Representative of More than 5,000 Standardized Vickers Units for Every Hydraulic Power and Control Function



Still Many Bottlenecks in Way of New Car Production

Government Agencies Should Coordinate Changes in Regulations and Relaxation of Controls

Although the official go ahead on production of civilian automobiles has been given the industry by the War Production Board, the benefit is more apparent than real, according to men in the industry. Actually it would have made little difference had the official word not come until June 30, since materials for building cars cannot be delivered until after July 1 under the open-ending of the controlled materials plan. The green light ostensibly permits manufacturers to order materials now for delivery after July 1, but actually WPB has been telling the manufacturers for weeks that they could do so. In effect the order legitimizes all the preparatory work that had been authorized piecemeal beforehand.

It is apparent, however, that there are still many bottlenecks in the way of car production, according to George Romney, Managing Director of the ACWP. Various Government agencies should coordinate their changes in regulations and relaxation of controls, or take other specific action, he said. WMC should eliminate manpower controls which are threatening the materials supply because of mal-distribution of manpower. The problem can be greatly alleviated, he said, by permitting unrestricted flow of workers to industries where they are needed.

Other action necessary to insure speedy resumption of cars, Romney stated, are revocation of OWMR Order 5-10 which restricts production in the fourth quarter above that of the third quarter without specific approval, elimination of WMC classifications, removal of the 1 per cent restriction on use of technical manpower for reconversion work, since it now is merely a "nuisance" clause, recognition by local draft boards of the importance of reconversion work, especially in the tool and die and machine tool industries, issuance of prompt and workable procedures by SPB and the procurement services for sale of machine tools and production equipment, and lifting of regulations prohibiting release of company-owned machines on war work.

At a press meeting announcing the green light, Henry P. Nelson, WPB Special Administrator, stated that quotas for individual companies would be set shortly and probably would be based on the same ratio that prevailed when production was halted by the war early in 1942. It is understood from a reliable source that quotas were discussed at the industry's meeting with WPB and that the individual allotments based on production of 2,146,000 cars annually, are likely to be as follows, with perhaps minor adjustments; General Motors 951,000, Chrysler 496,000, Ford 399,000, Studebaker 93,000, Hudson 68,000, Packard 61,000, Nash 58,000 and Willys 20,000. Companies which feel themselves aggrieved may appeal their quota to WPB and any new car manufacturers may apply for a quota.

It is expected that about the same ratio between standard and deluxe models will prevail as did before the war, Nelson stated.

When production starts Ford and Chevrolet are likely to concentrate production at first in their home assembly plants. It is understood that Chevrolet probably will shift some of its war work from Flint to its Buffalo plants to make room for car production. First Fords will be made at the Rouge plant, but with branch plants rapidly becoming cleared of war work it is expected that these will get into the picture before too long. In 1941, 88 per cent of all Ford and Mercury assemblies were at branch plants. The Dallas, Louisville and Richmond, (Cal.), branches are winding up their war work by the end of July and will be in good shape to start operation as soon as parts can be shipped. The Edgewater, N. J., plant also is in good position and the Buffalo branch is being readied, as is the one at St. Paul. Other branches at Memphis and Kansas City are still involved in war work expected to end in July. The Somerville, Mass., plant and the tank depot at Chester, Pa., however, are uncertain since there is no indication how long they will be tied up with war work.

Chrysler Corp. officials, as usual, had no comment to make when asked about their relative position in getting back into car production.

Commenting on the green light order, George W. Mason, President of Nash, stated that his company would be in production as soon as materials are available. This statement indicates that Nash is in good shape so far as facilities are concerned and is waiting only for materials to free up before getting into production. Both the Kenosha plant and the body plant at Milwaukee are understood to be fairly well along on reconversion, although there still is considerable war work going on.

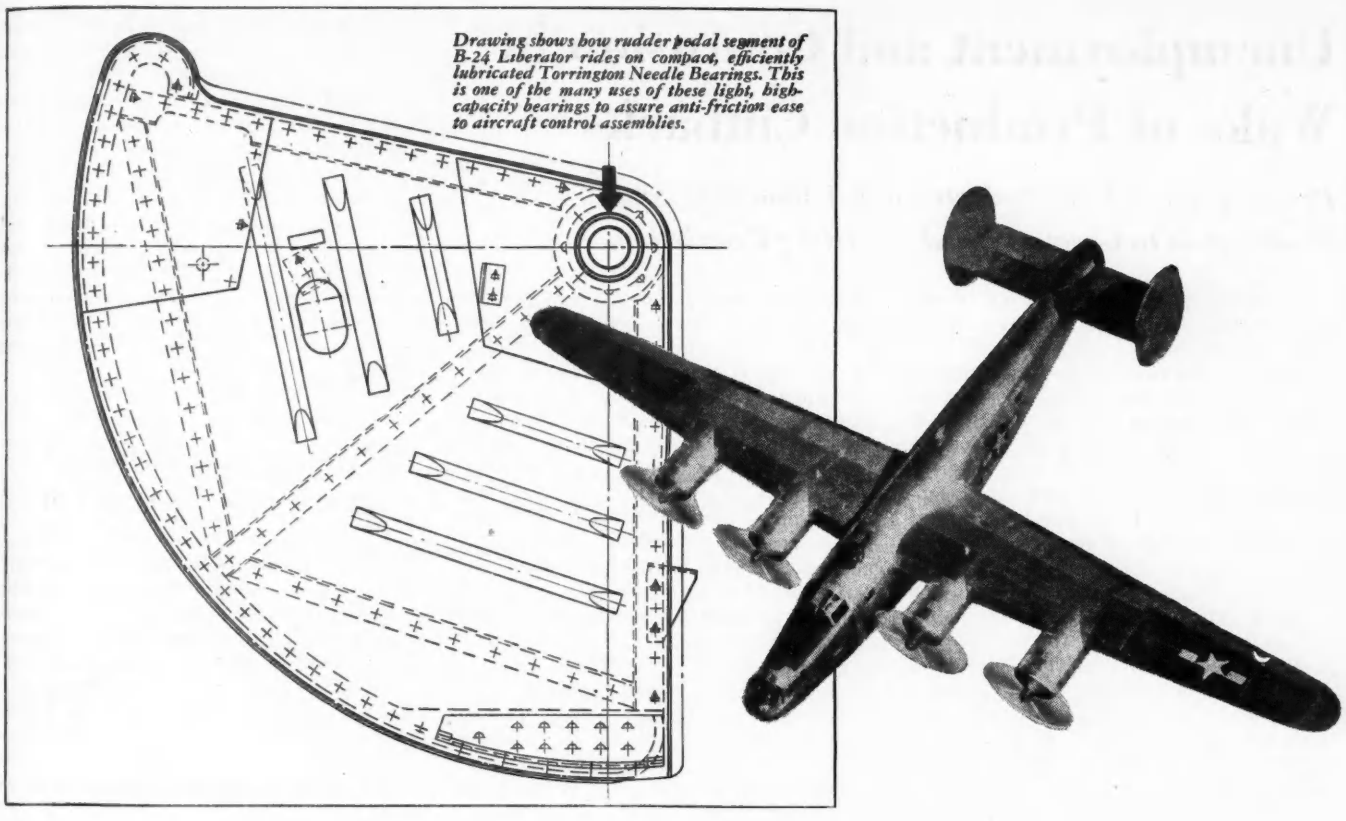
A. Edward Barit, President of Hudson, stated that his company will get back into car production as rapidly as possible. Although part of Hudson's facilities are tied up with work for the Japanese war, it is believed that there will be plenty of space left for the production of the quota allotted them. Hudson is fortunate in that it makes most of its own components such as engines, bodies, axles, transmission, etc.

Packard is the only company to come out with a definite statement about the date the first cars are expected off the line. George T. Christopher, President, has announced that his company is looking for the first 1946 models to come off the line by October or November. Packard has purchased additional plant space during the last year in which to place its war work and release space in the main plant for automobile production. The company before the war made a great many of its own parts such as engines, chasses, axles and gears. Bodies will be provided by Briggs, which is understood to be in good condition for reconversion.

General Motor officials were noncommittal about their plant, but it is felt in the industry that GM will be ready to go as soon as most other companies. C. E. Wilson, President, previously had announced that production would not be concentrated on one particular make in the GM line, but that all divisions would receive an even break. He stated also that the ability of the Fisher Body Division to get out from under war work would be an important factor in resuming production.

Fisher Brothers Bid for Control of Hudson

A bid by Fisher Brothers, Detroit automotive family, to acquire a controlling interest in Hudson Motor Car Co. through purchase of 400,000 shares of unissued stock at book value was revealed to stockholders by A. Edward Barit, Hudson President, at the annual meeting May 21. Book value of the stock on last Dec. 31 was $22.61 a share. The day before the meeting, however, the stock closed at 30¼ following a spectacular rise in recent weeks. No decision has been made on the offer, Barit said. Fisher Brothers are noncommittal.

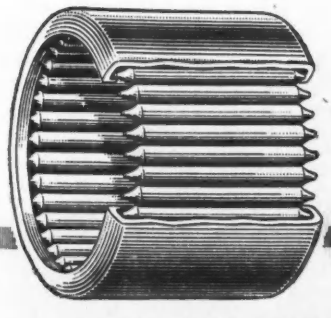


Drawing shows how rudder pedal segment of B-24 Liberator rides on compact, efficiently lubricated Torrington Needle Bearings. This is one of the many uses of these light, high-capacity bearings to assure anti-friction ease to aircraft control assemblies.

Rudder Pedal Segment of B-24 Liberator Rides on Torrington Needle Bearings

It is no surprise that the rudder pedal segment of the mighty B-24 Liberator, rides on light weight, compact Torrington Needle Bearings. For their full complement of small diameter needle rollers packs high capacity into small space, provides an extra margin of safety with the efficiency and reliability that is characteristic of these modern, self-contained anti-friction bearings.

Can you visualize these Torrington Needle Bearing advantages in terms of *your* product . . . aircraft or automotive equipment . . . machine or portable tools . . . household or other equipment that you want to operate with maximum ease, combined with minimum size, weight—and cost? Our Catalog 32, showing the wide range of types, sizes and applications, will help you. Write for it today.



THE TORRINGTON COMPANY

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TORRINGTON NEEDLE BEARINGS

Unemployment and Confusion in Wake of Production Cutbacks

Pressure from Both Industry and Labor May Spur Washington to Greater Speed in Lifting Restrictions

Cutbacks in war production in the automobile industry are leaving in their wake considerable unemployment and confusion. Because of the complicated interlocking of contracts in various plants, cancellation of a prime contract is felt all down the line of suppliers, with the result that, in cases like the pending termination of the bomber contract at Willow Run, the tremors of dislocation are felt by large numbers of sub-contractors. The one hopeful factor in the situation is that the resulting pressure from both industry and labor will spur Washington to the utmost possible speed in lifting restrictions on reconversion activities.

It should be noted, however, that there are certain conditions prevailing in the matter of materials which will govern the speed with which resumption of civilian manufacturing can begin. Although restrictions on use of steel, copper, and aluminum are slated to be lifted soon, this will avail little if such materials as textiles, tin, lead, cadmium, and other vital components are in such short supply as to prevent their use in civilian goods. At this writing, the supply picture is not clear, although the armed services have had plenty of time to evaluate their needs for the Japanese war. It is thought that these needs probably have been defined to WPB, but that agency has not made any comment yet, pending its study of available supplies.

Automobile manufacturers, of course, are welcoming cutbacks which give them a chance to clear out their plants and get factory layouts completed in preparation for resumed production of cars. Probably the most fortunate in this respect is Ford Motor Co. In recent weeks, it has seen the following cutbacks: Willow Run bomber plant scheduled to close by Aug. 1; reduction in output of Pratt & Whitney aircraft engines at Rouge plant by 400 a month, with this contract expected to be finished by September; steep cutbacks in its Army jeep program from 5000 per month to termination in July; termination of the contract to build M-8 armored cars at the Twin City branch; a reduction of 1700 units per month in the M-20 armored car at the Chicago branch, a 50 per cent reduction of the production schedule of Weasels, amphibious cargo carriers, which is slated to get into production at the Somerville, Mass., plant in August with termination set for next April. As a result of these cutbacks, Ford has relatively little war work left, the principal jobs being the robot bomb engine at the Rouge, the glider contract at Iron Mountain, Mich.; the jettison gas tank contract and some armor plate orders at the Rouge, and aircraft generators at Ypsilanti. All of these are relatively minor, considering the size of Ford facilities, and the company should be able to make sizeable inroads on its plant layout problems. In fact, it is well known that work is going on at a rapid pace in getting assembly lines and conveyers installed. Although no accurate figures have been issued, it is estimated that employment at the company is at least 20 per cent under the wartime peak.

Production of B-17 Flying Fortress engines at the South Bend, Fort Wayne and Chicago plants of the Studebaker Corp. will be discontinued after July 31. Approximately 7500 workers will be laid off. A projected 47 million cancellation in its M-4 tank contract has caused Fisher Body Div. of G.M. to lay off more than 1100 persons at its Flint and Grand Blanc plants. Chevrolet Div. has reduced its working force at Flint by 1000 because of a cutback in production of Pratt & Whitney aircraft engines. Termination of the AC Div. contract for machine guns will throw 3000 persons out of work by June 30, and a previous cancellation for aircraft engines used in the B-24 bomber has released more than 4000 at the Buick plant, making a total of more than 9000 persons affected in the Flint area.

Indicating how war production may be cut back or terminated in one plant and increase in tempo in another, Pontiac Motor Div. of G.M. has completed tooling and is now in production of five-inch high velocity assault rockets for the Navy. Following completion of its Oerlikon gun contract, the company undertook the dismantling and removal of more than 1000 gun making machines, and then installing presses, furnaces, and conveyer lines for rocket production. The whole job was accomplished within 75 days. Pontiac produces the entire rocket, with the exception of the nose fuze and explosive charge.

Chevrolet Plans to Build a Lightweight Postwar Car

Chevrolet Division of General Motors Corp. plans to build a lighter weight and more economical car in the postwar period after the fall of Japan, according to C. E. Wilson, president. Neither Mr. Wilson or other officials of the Corporation would divulge any details of the car, stating that it still is in the idea stage and that it will be a considerable period after the end of the Japanese war before the car will go into production.

The announcement indicates a shift in plans of the Corporation since Mr. Wilson last fall stated under questioning by the press that General Motors at that time had no plans for such a car. He did, however, say that the Corporation would build any kind of car that the public demanded. The decision to build a light car therefore is considered to indicate a potential public demand, and also to be an answer to the competitive challenge offered by the Ford Motor Co. which has announced that it will be in the field with an economy car to be priced about 25 per cent under the regular Ford line.

International News photo

Army's New M-26 "General Pershing" Tank

This low-swung 45-ton tank, developed as the answer to the German Tiger tank, will now be employed against the Japs. Built by the Fisher Body Co., the General Pershing attains a speed of 25 miles per hour.

The CONE AUTOMATIC MACHINE COMPANY sees many GOOD THINGS AHEAD

It is reported that . . . . . .

A new aluminum alloy, R-303, is claimed to be non-corrosive and to have twice the compressive strength of structural steel. *Reynolds Metals Co.*

get ready with CONE for tomorrow

A method has been announced for transmitting television programs over ordinary telephone lines, instead of coaxial cables or air relays, and for the recording of television in a manner comparable to the recording of radio. *Packard Mfg. Co.*

get ready with CONE for tomorrow

The fuel being used in the B-29's over Japan is said to have an octane rating well over 130. *Aero Digest.*

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This year's models of one make of highway bus have rubber springs. *Twin Coach.*

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A newly installed turbine generator, in a city power station, has twice the capacity of the 14 previously installed units combined. *Fisk Station, Chicago.*

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One of our new aircraft engines weighs only 0.97 pounds per horse power. *Wright Cyclone 9.*

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The first American-built steam turbine locomotive is being given a service test. *Baldwin Locomotive Works, Penna. R. R.*

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Army aircraft are being "jacked up" when on soft ground by inflating large rubber pillows placed under the wings. *Science News Letter.*

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A manufacturer of aluminum utensils is planning to make aluminum kitchen furniture. *Aluminum Cooking Utensils Company.*

White or light colored vitreous enamels can now be applied directly to steel surfaces. *Inland Steel Company.*

get ready with CONE for tomorrow

A company has been established to process three-dimensional photographs (vectographs) in quantity for civilians. *Three Dimension Company.*

get ready with CONE for tomorrow

A new processed wood called "Staypak" has been developed that is claimed to be twice as tough as "Compreg". *U. S. Forest Products Lab., Madison, Wisconsin.*

get ready with CONE for tomorrow

In one city a system of radiotelephone communications between a central station and public or private vehicles is expected to be in operation by next fall. *Pittsburgh.*

An airport bus, designed to connect small towns with main airlines, has a ticket office, flight control tower, freight space, lunch counter, two-way radio, telephone and washroom, as well as seating space for passengers. *Parks Air Transport East St. Louis.*

get ready with CONE for tomorrow

Reports say that one of our largest automobile manufacturers is planning an entirely new 5-cylinder car to sell at about 20% below the lowest prewar level. *Ford.*

get ready with CONE for tomorrow

A new process so reduces the cost of making gasoline from natural gas that a large refinery is being planned for this purpose. *M. W. Kellog, Jersey City.*

get ready with CONE for tomorrow

30 to 50 ton trucks as long as 75 feet have been built and are now being put to specialized uses, such as the hauling of ore, aircraft and prefabricated houses. *Scientific American.*

SPEED
for tomorrow's competition
Sixteen tools on an 8-spindle Conomatic complete this part in 23 seconds — including the small hole on the end.
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18

New Car Starting Quota Set at WPB Meeting

The automobile industry has agreed to an initial starting quota for resumption of automobile production set at about 215,000 cars for the last half of 1945. The decision was reached at a meeting with War Production Board officials in Washington May 17. Although the starting quota is only about 10 per cent of the 2,146,786 cars which the industry has contended is a minimum economic annual production rate, automobile manufacturers accepted the 215,000 starting rate when WPB spokesmen insisted that free steel would be available for only that number. Industry men, however, asked, and WPB agreed, that estimates on materials be revised constantly so that if there are any improvements in materials supplies the quotas can be revised upward. WPB estimates, based on cutbacks in war production to date, indicate that steel available in the first quarter of 1946 should permit production of about 400,000 cars during that period, and that in the first year of production, output should reach 2,150,000 units.

Automobile spokesmen say they accepted the small quota because they would rather get started and then meet material shortages as they come up than to wait until the materials picture is entirely favorable. They will use substitute materials when necessary although they emphasized that this would not mean an inferior car. Some of the substitutes might include use of war-developed bearings which use very little or no tin. Other prospective shortages include lead, textiles, and chemicals for paints.

Other factors which may have influenced the industry to accept the low initial quota are the competitive advantage of an early start, the buffer of earnings from continued war work to help carry the burden, the possibility of amortizing the early period losses over the entire model year, and the use of funds set aside during the war for postwar contingencies. Also, some of the men in the automotive industry believe that WPB's estimates of the steel supply are far too low and that there will be considerably more available than that agency expects, with a subsequent early boost in quotas.

Prices of new cars were not discussed at the meeting, but it is understood that OPA already has reopened its studies started last summer and that the matter will be taken up with the industry at an early date.

WPB told the manufacturers that it would not attempt to dictate any model changes they might contemplate, but that it would not give any priority assistance to effect changes. However, it is well known in Detroit that tool and die shops, especially the "captive" ones, have been loaded for weeks with work on front fender and radiator grille dies, with the result that the new cars will not look too much like the 1942 models. It is pretty well established, on the other hand, that mechanically there will be few important changes, the principal ones being elimination of "bugs" which have shown up in wartime performance.

Truck manufacturers attending the meeting were told that WPB recognizes the need for light trucks for commercial use and wants as many as possible as soon as possible. This does not mean an absolute green light, but it does mean that priority assistance will be given on materials and equipment so that production can be increased as much as is consistent with military truck requirements. Consequently, trucks will have preferential treatment over passenger cars. The industry also was informed that it faces heavy cutbacks in lighter model trucks, ambulances, personnel carriers, and the like, and to a lesser degree in medium, light-heavy, and heavy-heavy trucks.

Another important development is the lifting of all restrictions on replacement automotive parts to permit unlimited production of both functional and non-functional types. The present list of defined parts will be retained in L-158 and producers will be given priority assistance and "firm" CMP

(*Turn to page* 114, *please*)

Obituary

Dr. E. W. Engle, 57, research and consulting metallurgist for Carboloy Company, Inc., died at his home in Detroit on April 26.

Emil C. Traner, 68, veteran Rockford industrialist and supervisory board chairman of Rockford Clutch Division, Borg-Warner, died May 7 at his home in Rockford, Ill., after an extended illness.

Richard Milton Hollingshead, 77, president and founder of R. M. Hollingshead Corporation, Camden, New Jersey, died May 16 at Pennsylvania Hospital, Philadelphia, after a short illness.

PUBLICATIONS

Bulletin M-1382 has been issued by Cincinnati Milling Machine Co., describing a variety of special **attachments** for **milling machines.***

Ampco Metal, Inc., has announced two new booklets, No. 59, describing **Ampcoloy alloys,** a series of bronzes of controlled analysis. The bulletin contains photomicrographs, physical properties and chemical compositions of the Ampcoloy series, which include aluminum bronze, high lead bronze, tin bronze, manganese bronze, beryllium copper and high conductivity alloys. Bulletin 66, in which is contained a discussion on **how to machine Ampco metal,** is illustrated with diagrams and photographs and treats fully of the various phases of machining, gives a table of recommended lathe feeds and speeds and tool design and inspection.*

A new circular has been published by The **Fellows Gear Shaper Co., covering** the application of the gear shaper to the automatic cutting of straight-sided splines. Described specifically in the circular are **7 and 7A-Type Fellows Automatic Indexing Gear Shapers,** for cutting internal and external splines.*

Erickson Tools, Div. of Erickson Steel Co., has released a new set of Data Sheets on its line of **precision holding tools.** Material included is detailed drawings and specifications of Erickson Model 01 and 02 Chucks, Precision Collets, Adjustable Floating Holders, Expanding Mandrels, etc.*

Flash Welding—A Solution to Assembly of Forged Parts, is the title of a new 4-page, illustrated folder issued by The American Welding & Mfg. Co. It includes a description of the advantages of flash welding as a saver of machine time, stock, weight and handling. Methods by which welded assemblies cut production costs are also described.*

(*Turn to page* 103, *please*)

Business in Brief

Written by the Guaranty Trust Co., New York. Exclusively for AUTOMOTIVE AND AVIATION INDUSTRIES

Moderate fluctuations of business activity are indicated by current reports. *The New York Times* index for the week ended May 5 stands at 145.3, as against 146.4 in the preceding week and 144.1 a year ago.

Electric power production declined more than seasonally in the week ended May 5 and was 3.9 per cent. above the comparable level last year, as against a similar rise of 1.8 per cent. recorded a week earlier.

Railway freight loadings in the same period totaled 863,399 cars, 4.0 per cent. fewer than for the week before but 3.3 per cent. above the corresponding number a year ago.

Crude oil production during the week ended May 5 averaged 4,839,215 barrels daily, 34,400 barrels above the figure for the preceding week and 320,665 barrels more than the output a year ago.

Production of soft coal in the week ended April 28 is estimated at 11,980,000 net tons, as against 11,250,000 a week earlier and 12,237,000 tons a year ago. The output thus far in 1945 is 8 per cent. below the corresponding quantity last year.

Engineering construction contracts awarded during the week ended May 10, according to *Engineering News-Record,* totaled $38,910,000, as compared with $40,576,000 in the preceding week and $42,209,000 for the corresponding week last year. For 1945 to date, however, the contract total is 12 per cent. below the comparable figure in 1944.

The Irving Fisher index of wholesale commodity prices registered a slight recession in the week ended May 11, standing on that date at 114.97 per cent. of the 1926 average, as against 115.16 a week earlier and 112.91 a year ago.

Member bank reserves increased $137,000,000 during the week ended May 9, reflecting a rise of $183,000,000 in total Reserve Bank credit, an increase of $24,000,000 in Treasury deposits with the Reserve banks and other changes. Excess reserves remained at an estimated total of $900,000,000. During the same period, earning assets of reporting member banks registered a decline of $181,000,000, including a recession of $75,000,000 in commercial, industrial and agricultural loans.

LODGE & SHIPLEY LATHES at work...

. . . we would be severely handicapped without our fine accurate Lodge and Shipley Toolroom Lathe

NORTON LASIER CO.

LCN

Before converting to war work, Norton Lasier made the famed L. C. N. concealed and surface door closers in 86 types and sizes! To assure precision tools for the production of their wide range of closers, Norton Lasier depend on their Lodge and Shipley 14" Toolroom Lathe.

At present, this versatile Lathe produces the tools for vitally required aircraft parts. But when Norton Lasier again turns to building L. C. N. closers for the nation's fine buildings they will rely even more on their L & S Lathe. For many of the new tools this Lathe will be called upon to produce have already been designed—tools far in advance of those used before conversion.

Forward-looking firms like Norton Lasier, concerned with present-day and future tooling problems, find L & S Engineers helpful in their lathe recommendations. For detailed literature write on your company letterhead for Bulletin No. 508-BO.

THE LODGE & SHIPLEY MACHINE TOOL CO.

CINCINNATI 25, OHIO, U. S. A.

L & S LATHES

ENGINE — TOOL ROOM — AUTOMATIC — OIL COUNTRY LATHES

Gas Turbines in Aviation

(*Continued from page* 36)

this type is roughly equivalent to its net thrust hp as a complete power plant under flight conditions. Fig. 15 should be compared with Fig. 11 for a direct comparison of total power plant losses of conventional engine power plants and geared turbines with propellers.

It is possible to make a choice of the division of power outputs of a turbine propeller unit between jet exhaust thrust and the propeller shaft. For example, for a very high speed airplane that must still have a good take-off characteristic, 50 per cent of the power might be used in jet thrust and the remainder in the propeller. For ordinary applications, however, between 20 per cent and 25 per cent of the available energy should remain in the exhaust jet, the turbine shaft recovering the remainder. Thus, for the example chosen here, most of the energy is absorbed by the propeller with excellent overall power plant performance at low flight speeds, and with fuel economy at high power levels that is quite superior to the conventional power plant.

This type of power plant is equally adaptable to fighters or large airplanes. The improvement in fuel efficiency with increasing air speed and power results in somewhat higher cruising speeds than for aircraft with reciprocating engine power plants. The decrease in available power at higher altitudes makes it necessary to install gas turbine power plants that may have considerably more power at sea level and for low altitude climb than is now considered normal in airplane design. This is an advantage rather than a disadvantage, however; a propeller able to absorb the turbine's shaft output at 20,000 ft or 30,000 ft can efficiently handle the greatly increased output of the same turbine at sea level, due to the denser air at low altitudes. Thus a gas turbine power plant with a rating equal to that of a supercharged conventional engine at 20,000 ft altitude might have a take-off thrust at sea level 60 per cent in excess of the thrust of the conventional engine. A much shorter take-off run than normal is therefore possible, and rate of climb is greatly superior to the convention aircraft.

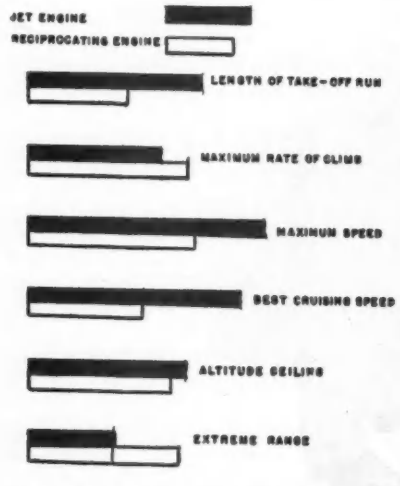


Fig. 13—General performance comparisons for the two airplanes of Fig. 12

The field of usefulness of the gas turbine with propeller then extends to all aircraft requiring engines of greater than perhaps 1000-2000 hp, and designed for all speeds up to and in excess of 500 mph.

The total thrust hp requirements of a typical large (4 engine) airplane at 20,000 ft altitude are shown in Fig. 16. Curve A is for the plane with reciprocating engines and includes all power plant drag losses but does not include propeller efficiency. Curve B is for the same airplane but with gas turbine engines geared to propellers. Curve C is for a jet propelled aircraft similar in appearance to the turbine-propeller plane but without the propellers. The gross weight in each instance is assumed to be 120,000 pounds and power plant plus fuel weights are held constant.

The conventional engine installation is four engines supercharged to 2000 hp each at 20,000 ft. In the jet propelled version, four 6000 pounds static thrust engines are used; this will give 24,000 pounds take-off thrust, approximately equal to the take-off thrust of the plane with reciprocating engines. Once in flight, two of the jet engines will be shut off for cruising under 25,000 ft altitude and the other two will be used for propulsion. In the gas turbine geared propeller version, four engines capable of delivering 2000 shaft hp each at 20,000 ft are used. At take-off these engines will deliver 3200 hp each. A propeller designed to absorb 2000 hp in the low density air of 20,000 ft altitude can handle 3800 hp at sea level with the same level of propulsive efficiency. Power availability curves for these power plants are also shown on Fig. 16; power availability is shown for flight with either two or four jet engines in use. Thus, at take-off the three versions appear in Table I.

Cruising conditions are shown in Table II; and as mentioned before jet cruising is on four engines at 35,000 ft and on two engines only at 20,000 ft; fuel consumption with four jet engines operating is prohibitive for any operations other than at take-off or very high altitudes. Cruising with four gas turbine propellers in use is tabulated, and also with two turbine propellers in use and two feathered; a suitable drag allowance has been made for the feathered propellers.

The sensitivity of the gas turbine propeller to partial load operation is seen in Table II, an 18 per cent increase in range is obtained by operating two engines close to full load and maximum efficiency rather than operating four engines at less than half load.

(*Turn to page* 52, *please*)

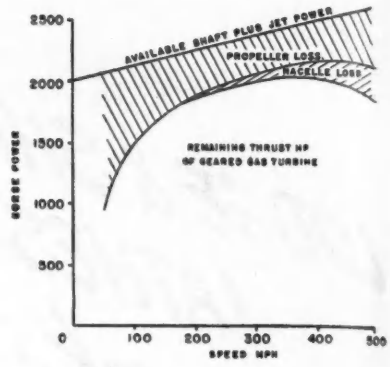


Fig. 14—Typical flight losses estimated for a gas turbine engine with geared propeller. Note that jet thrust almost off-sets propeller and nacelle losses through a large part of the speed range shown.

TABLE I

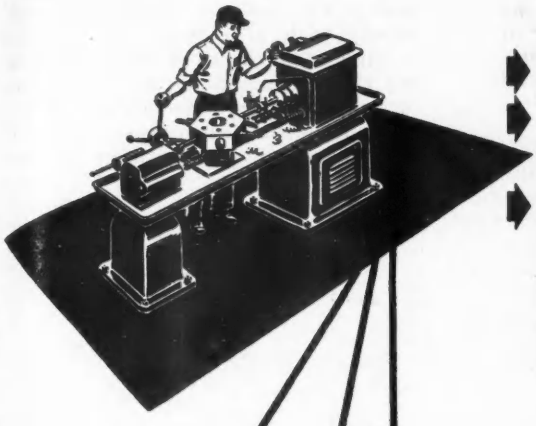
TAKE-OFF CONDITIONS

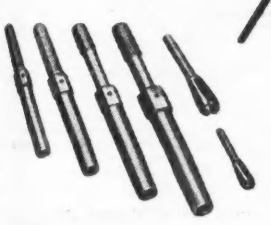
	Gross Wt. (lb)	Installed Power Plant Wt. (lb)	Fuel Wt. (lb)	Take-off Thrust (lb)
Conventional	120,000	20,800	40,000	28,000
Turbine Propeller	120,000	15,200	45,600	44,000
Jet Propelled	120,000	8,000	52,800	24,000

TABLE II

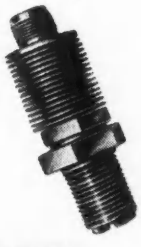
CRUISE CONDITIONS (20,000 FT. ALT.)

	Best Cruising Speed mph	Miles per lb fuel	Extreme Range Miles
Conventional	250	0.120	4800
Turbine Propeller (4 engines)	300	0.125	5700
Turbine Propeller (2 engines)	280	0.145	6600
Jet Propelled (2 engines)	350	0.050	2650
Jet Propelled (4 engines 35,000 ft. alt.)	460	0.066	3500





THESE AIRCRAFT cable terminals require clean turning, threading, drilling and milling. The uniformity of Carpenter Stainless #8 (Type 303) was a big factor in maintaining volume production on these parts.



THIS FINNED aircraft spark plug is an excellent example of the results obtainable with Carpenter Stainless #5 (Type 416).

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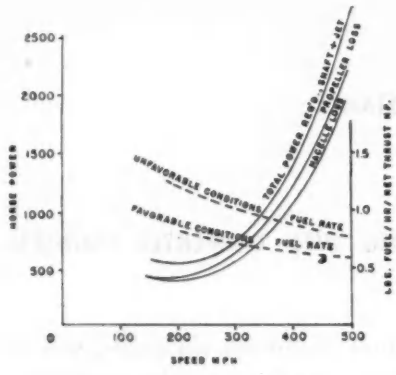

Fig. 15—Typical flight losses of the geared gas turbine power plant of Fig. 14 when operated on the power-required curve of a high speed aircraft at 20,000 ft altitude.

This is a fundamental difference that exists between turbines and reciprocating engines, and it makes necessary a careful selection of turbine ratings for any given application if maximum fuel economy is to be gained. The same conditions are true of jet propulsion engines, and it is profitable to operate close to 80 per cent of full rating of the turbines either by shutting down excess power units or going to a sufficiently high altitude to decrease the maximum rated output to a value near the required flight power. In the case of jet propulsion, since high speed and high propulsive efficiency go together, very high altitude operation is essential to maximum flight economy.

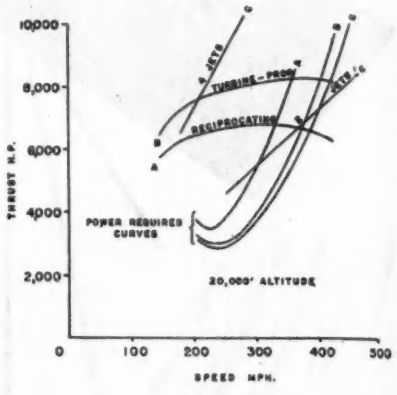

Fig. 16—Power available and power required curves of a large (120,000 lb.) airplane with four engines; curves A are for reciprocating engines, B for gas turbines geared to propellers, and C for jet engines.

The general characteristics of the three airplanes described in Tables I and II are compared by the bar charts of Fig. 17. It is interesting to note that the gas turbine propeller airplane is superior to the conventional aircraft on every count with the exception of altitude ceiling, where they are about equal if the reciprocating engines are turbo-supercharged. Since turbine propeller fuel economy and installed power plant weights are both superior to

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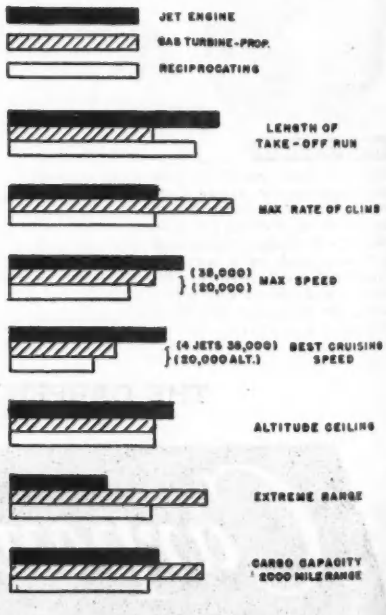

Fig. 17—General comparisons of the characteristics of the three airplanes of Fig. 16 and Tables I and II.

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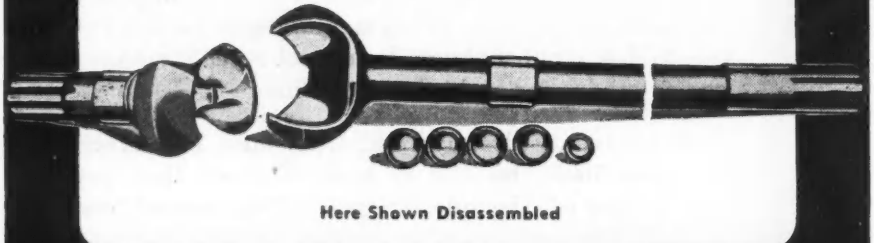

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those of the conventional engine, the long range and short range load carrying abilities of the turbine propeller aircraft are superior to the conventional one. On the other hand, the jet propelled aircraft has a very light power plant installation and can get off the ground for very short flights with about five tons more payload than the conventional aircraft, and about three tons more than the turbine propeller version. However, jet propulsion requires so much more fuel than other types of power plant, that at about 2000 miles extreme range the jet plane loses out to the reciprocating engine and is far behind the geared turbine in payload carrying ability.

As was found in the case of the jet propelled fighter, the jet bomber or cargo plane must be limited in use to relatively short range, very high speed, high altitude operations which can stand the expense of high fuel costs, until we have learned more about the aerodynamics of flight at speeds over 500 mph. The gas turbine with a geared propeller, however, has immediate applications in all classes of service where requirements are much above 1000 hp at usual flight altitudes, and should be ready for use when aircraft designs require 10,000 hp or more in a single power plant unit.

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Expansion of Airline Routes

(*Continued from page* 30)

posing the use of a different type of aircraft, are the applications which specify use of the helicopter, a device which holds great promise but which has not been used commercially and about which very little is definitely known relative to operating cost and future carrying capacity.

A third category embraces the so-called pick-up air service, largely confining service to mail and express and connecting a large number of cities 15 or 20 miles apart with trunk line stations. The airplanes used in this sort of operation would be equipped with a device perfected by the late Richard C. du Pont to pick up a cartridge containing mail and express "on the wing," so to speak, without making stops, and releasing inbound loads by drop-delivery. Certain of these proposals include landings for passengers at flagstops.

We cannot know what the next 10 years will bring in technological advances. We can expect great things. Full development of the heicopter, for example, may provide the key to effective competition for short-haul city-to-city traffic; and costs may one day be reduced to the point that the 2c per mile bus and coach market may be cultivated by the airlines. We do not believe that these developments are in view over the next 5 years, and therefore we feel that route expansion for local and feeder air service to smaller cities and towns, as well as the establishment of additional airlines for that purpose at the present time, is premature.

Non-Scheduled Services

Typical of this type of service is that offered by the fixed base operator, or as they prefer to be called, the "Airport Service Operator." These people usually operate from a single fixed base or airport and offer such services as the following: flying instruction, rental of hangar facilities, sales and service of aircraft, crop dusting, aerial photography, sky advertising, plane rental, sightseeing, taxi and charter service. They usually operate small airplanes, from two to six passenger, although some of the sightseeing services use larger equipment.

There would seem to be a definite and important place for the Airport Service Operator offering irregular route, non-scheduled service in the air transport picture. Many communities, too small to support trunk-line or feeder-line scheduled service, still have need of air transportation, and the Airport Service Operator would seem to be the ideal medium for furnishing this service.

Although no valid generalization can be made as to the size of towns where air transportation cannot be supported on a regular scheduled basis, the 27,000,000 people living in the 6000

(*Turn to page* 56, *please*)

Bearing engineers emphasize two requirements for good bearing performance. Keep the proper amount of lubricant in the housing and keep all foreign matter out.

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towns between 1000 and 25,000 population give some idea of the scope of the market for irregular route, non-scheduled operation by the Airport Service Operator. If each of the 6305 airports projected in the National Airport Plan is to have an Airport Service Operator with an average of four planes, then a total of 24,000 small aircraft will be engaged in this type of service.

The national air transportation policy requires that the expansion which is to come in air transportation be in accord with some specific pattern. The advantages which accrue from the imposition of a formal pattern before the system has been made unwieldy through the disorderly growth which accompanies the absence of regulation makes it desirable for the Board to establish this pattern by promulgating now the requisite regulations.

Air Cargo Routes and Services

Here technological progress in the fields of aircraft and power plant design and cargo handling methods will play an important part, but the influence of increasing volumes in lowering costs is well known and operates in the field of air transport also. Thus, we find ourselves within the well-known circle—volume, rates, costs, routes and services, and around again to volume. No one factor can be determined without first determining the others.

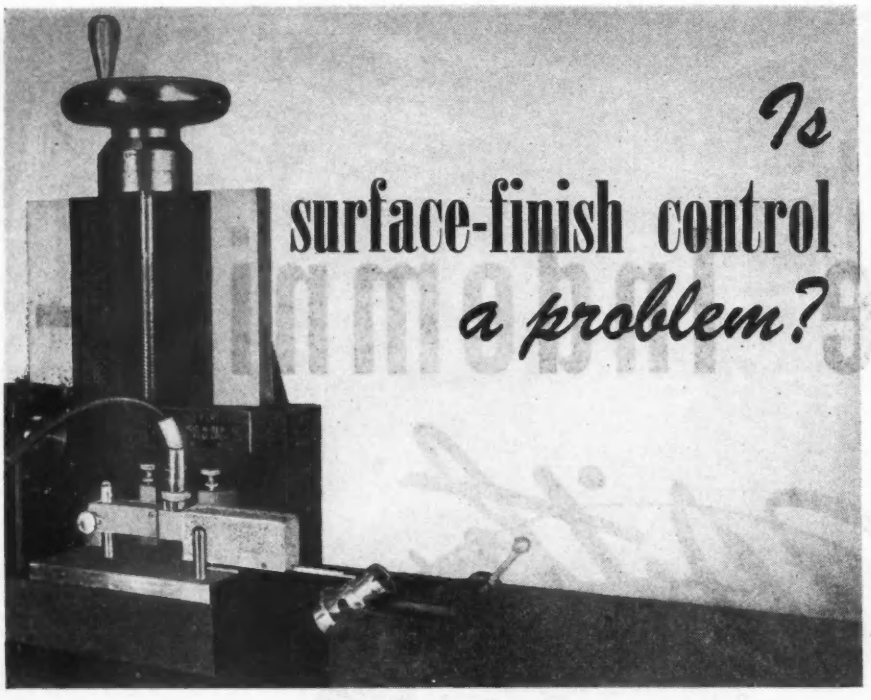
Passengers' baggage allowance, now 40 lb per person, will increase with the coming of larger transports; trunks and similar heavy baggage may also be carried in the normal routine as excess baggage.

First-class mail will probably go by air for distances of 400 miles, or over, or where a saving in time can be effected. Prior to the war, 12 per cent of all ton-miles of non-local first-class and air mail traveled by air.

Air parcel post, non-existent at the present time, would require 125 aircraft if the rates could be made sufficiently attractive for trips of 400 miles, or over, to attract one-half of the present surface volume.

A fleet of 200 all-cargo planes for the transport of express items can be visualized, if the rates are low enough to attract one-half of the present first-class railway express volume.

The field of perishables offers distinct opportunities in postwar cargo transport. Present experiments in this field show that rates of 15 to 20 cents per ton-mile can be absorbed in the selling price. There are problems to be solved, however, such as unavoidable delays en route and subsequent spoilage. Complete reliability of service in the transport of perishables will have to await installation of instrument landing systems and the continued use of a highly developed meteorological and dispatch system. Since the business of perishables is highly seasonable and since both producing areas and markets are constantly changing, it is possible that this type of air service will fall to independent contract operators.



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If you are now working on surface-roughness control or on post-war production plans, you will be interested in talking with one of our field engineers. Our representative would be glad to call at your plant to discuss the Profilometer and to demonstrate it on the work you are now doing. This demonstration call will incur no obligation on your part and may be arranged by addressing Physicists Research Company, 343 South Main Street, Ann Arbor, Michigan.

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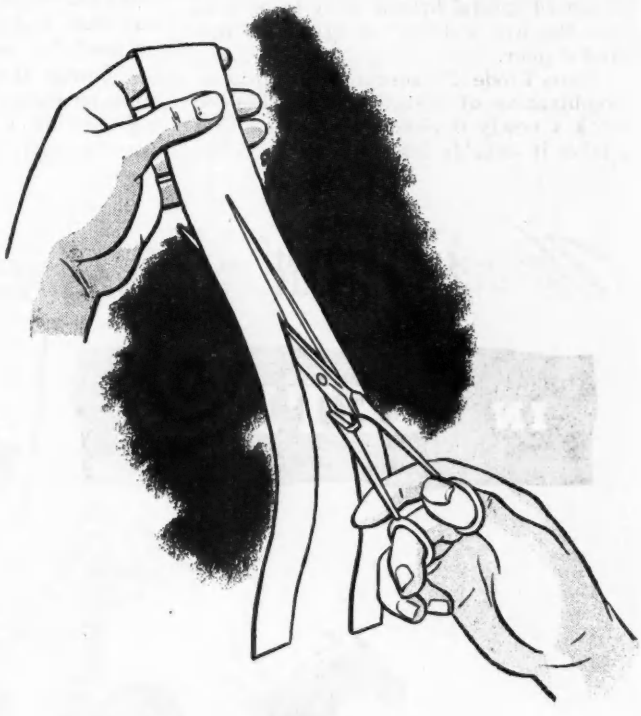

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New Products

(*Continued from page* 42)

Coated Bronze Electrode

The Eutectic Welding Alloys Co., New York, N. Y., has introduced an electrode for arc welding known as EutecTrode 28. The new electrode is a coated special bronze alloy to be used for the arc welding of bronze, brass, and copper.

EutecTrode 28 contains an unusual combination of metals and is shielded with a newly devised flux coating that makes it suitable for use either on alternating or direct current.

EutecTrode 28 is said to deposit dense and tough metal that is a good color match to most types of bronzes. It will give the welded area substantially the same corrosion resistance as these various base metals possess. It may also be used for welding copper and brass or joining these metals to steel, cast iron, or nickel alloys, and for overlaying steel or cast iron to provide a good bearing surface.

Pressure Detector for Hydraulic Systems

A pressure detector particularly adaptable for hydraulic systems for controlling hydraulic pressures and cutting off circuits at predetermined pressures, and for controlling surge loads, is offered by Cook Electric Co., Chicago, Ill.

It is called the "Hi-Pressure" switch, and is capable of withstanding 3000 lb

Cook Hi-Pressure switch

surge load, with a range of adjustment from 100 to 2000 lb with a 20 lb differential at 100 lb pressure which increases proportionately at higher pressures. The electrical capacity of this switch is 10 amp at 125 volts a-c. The pressure connection can be either ⅜-in. or ⅛-in. standard pipe thread.

All-Position, A-C Welding Electrode

An all-position a-c electrode which meets the requirements of the U. S. Navy Department Bureau of Ships and the standards for welding set by various associations has been brought out by Westinghouse Electric & Mfg. Co. This electrode, known as the ACP, is said to be capable of producing highest quality weld metal in over-head and vertical welding. It includes an arc pacifier that prevents excessive spatter loss during the negative half cycles and an arc stabilizer to aid in re-establishing the arc after each current zero.

The availability of an electrode capable of producing welds in overhead and vertical positions, having the high ductility and freedom from porosity necessary to meet the most rigid code requirements, will further accelerate the use of a-c welding.

Hinged-Type Wire Belt Hooks

The Bristol Company, Waterbury, Conn., recently placed on the market a line of hinged-type wire belt hooks, known as Bristol's belt hooks. These hooks are designed for joining all types of flat belting, including leather, fabric,

(*Turn to page* 60, *please*)

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Now is an ideal time for executive key men to talk about products — and how anti-friction bearings can be more effectively used at the "key man" posts. For industry has learned this lesson: Every new product, every rejuvenated old product, must be adequately equipped with bearings if it is to meet the merciless competition of tomorrow. Aetna engineers are ready — with a wealth of useful experience: good men to talk to.

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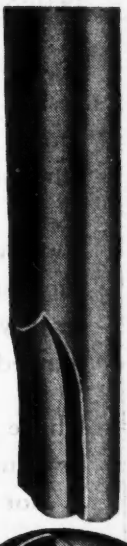

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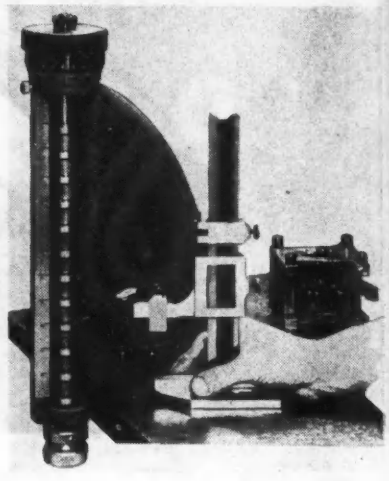
Gage for Surface Plate Work

Pla-Chek, a new gage for surface plate work, has been developed by Cadillac Gage Co., Detroit, Mich. It is made from a hardened steel bar with 12 steps spaced exactly 1 in apart with a micrometer screw thread ground on the lower end; a large micrometer



Pla-Chek gage

thimble graduated in 0.0001 in. on the upper end of the bar and a triangular-shaped support bracket.

(*Turn to page 64, please*)

Rotating Bearing Loads

(*Continued from page 28*)

ings is imposed on aircraft and certain automotive bearings and yet little attention has been paid to the dynamics of these oil films. While an improved oil film under such conditions has been recognized by a few investigators, it is not known that the above explanation has previously been presented. A rigorous solution of the mathematical value of the squeeze film is not yet available. It obviously depends on a greater number of variables such as the loading diagram, speed, flexibility of the bearing, surface finish, effective initial clearance, etc.

Appendix

The general equation for "time rate of approach" can not be solved for rectangular plates but a solution is obtainable for elliptical discs. Therefore, it will be assumed that the upper and lower halves of a bearing are elliptical

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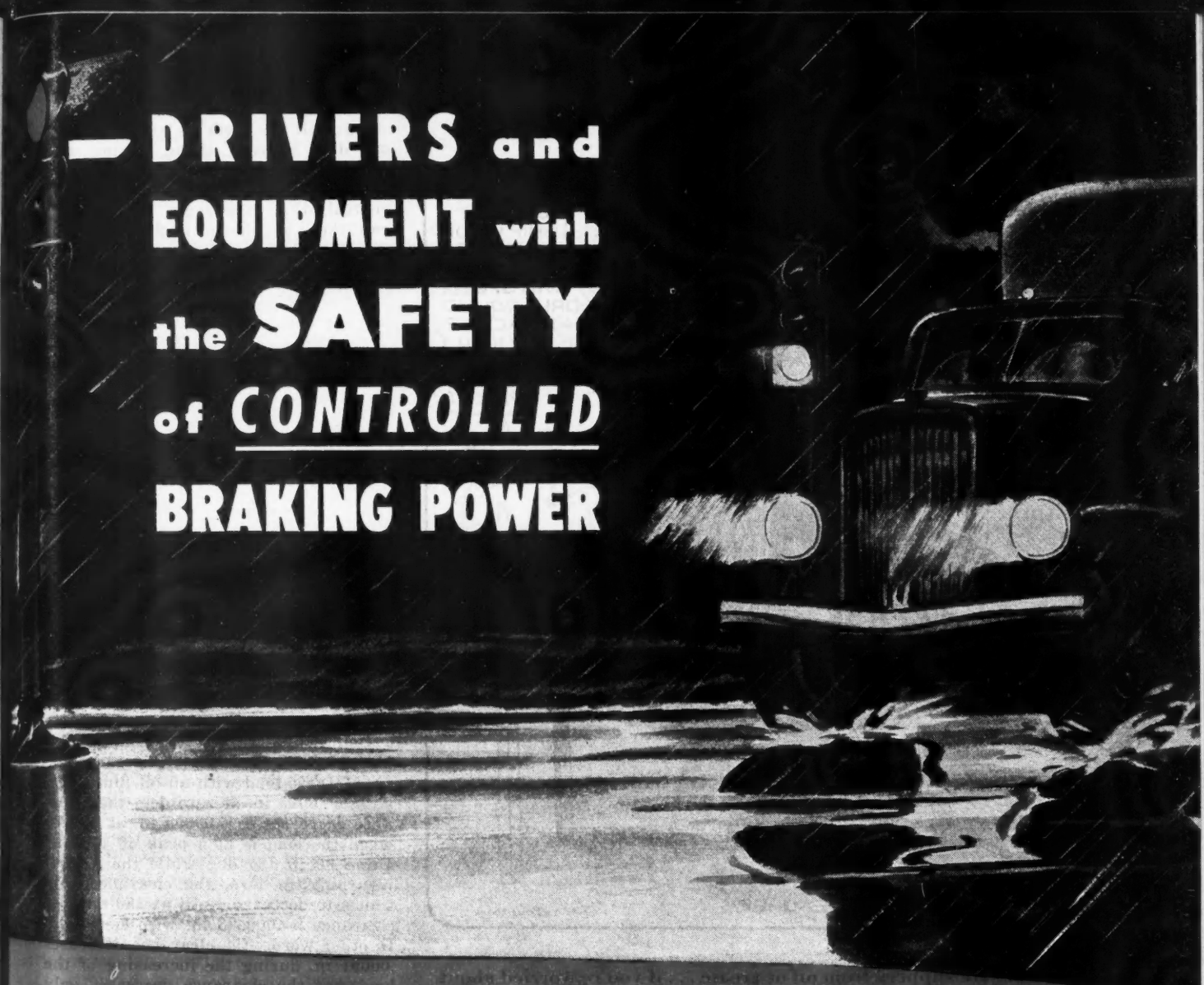
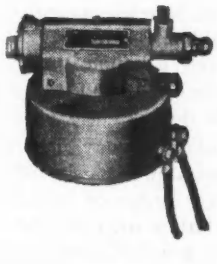


VARI-LOAD ELECTRIC BRAKES



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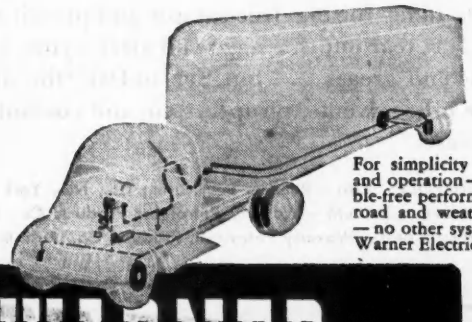

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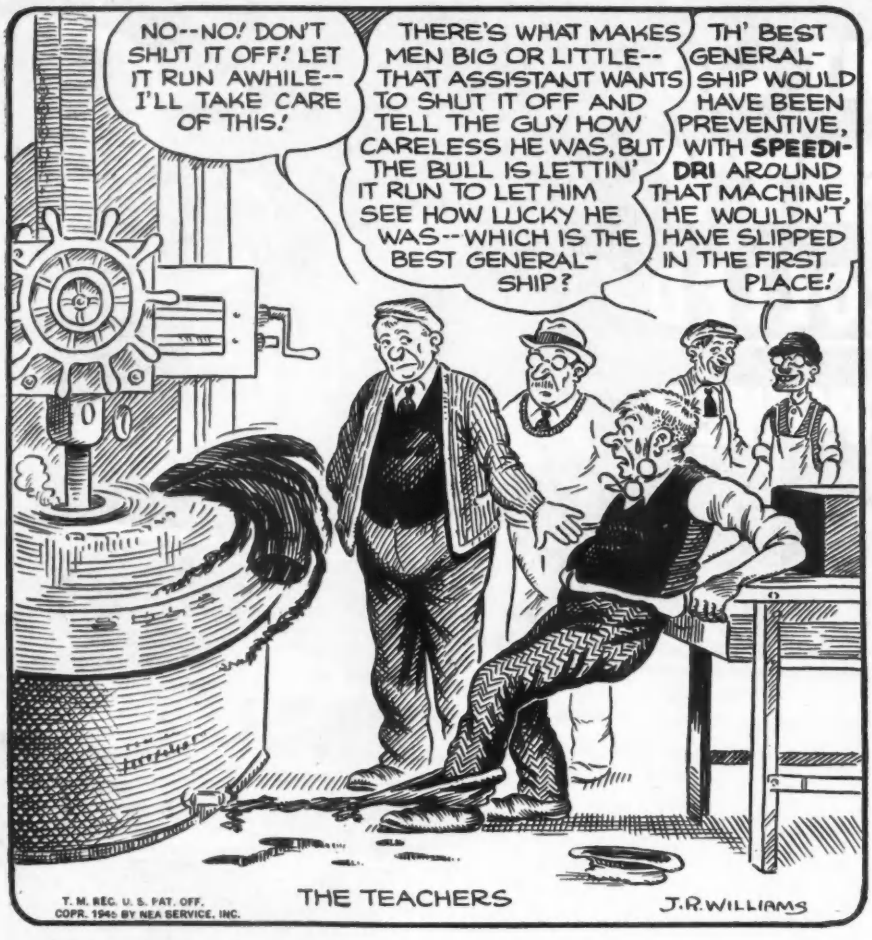
NO--NO! DON'T SHUT IT OFF! LET IT RUN AWHILE-- I'LL TAKE CARE OF THIS!
THERE'S WHAT MAKES MEN BIG OR LITTLE-- THAT ASSISTANT WANTS TO SHUT IT OFF AND TELL THE GUY HOW CARELESS HE WAS, BUT THE BULL IS LETTIN' IT RUN TO LET HIM SEE HOW LUCKY HE WAS--WHICH IS THE BEST GENERAL-SHIP?
TH' BEST GENERAL-SHIP WOULD HAVE BEEN PREVENTIVE, WITH SPEEDI-DRI AROUND THAT MACHINE, HE WOULDN'T HAVE SLIPPED IN THE FIRST PLACE!
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discs with the shaft as another elliptical disc between them, having total clearance equal to the diametral clearance. A sinusoidal force applied to the central disc, represents the load. It can then be shown (ASME Preprint No. 44-A-29) that the equation (1) can be solved for the oil film thickness at any instant:

$$h_2 = \sqrt{\frac{1}{\frac{2W_p\,(a^2+b^2)\,(1-\cos\omega t)}{\omega 3\pi\mu a^3 b^3} + \frac{1}{h_1^2}}} \quad \ldots \quad (2)$$

Where W_p = peak load = 4000 lb = 17.8×10^3 dynes

ω = radians/sec. = 100π (3000 rpm)

a = one half of the bearing diameter = .38 in. = 3.50 cm.

b = one half of the bearing width = .69 in. = 1.75 cm.

μ = oil viscosity = .21 poises

h_1 = max. oil film = .0038 cm. (.0015 in.)

Using these values the graph shown in Fig. 3 is obtained. It is seen that from a zero load with an oil film thickness of .0015 in. at zero deg, the clearance decreases to 0.00059 in. at 90 deg when the load is at a peak of 4000 lb. From 90 to 180 deg while the load is returning to zero, the clearance continues to decrease, until at 180 deg the clearance is .000433 in. with zero load. In other words, the clearance decreases .00091 in. during the increasing of the load, but the clearance decreases only an additional .000157 in. while the load is decreasing. Then as the load is applied to the other half of the bearing from 180 to 360 deg, the oil film is increased to its original value of .0015 in. On Fig. 3 is also indicated the minimum oil film thickness if the discs were assumed to be discs instead of ellipses. The difference is small.

The effect of speed on the minimum clearance is shown in Fig. 4, as calculated by varying the rpm (or w) in formula (2). At 3000 rpm, the value is the same as shown on Fig. 3 for 180 deg. In Fig. 5 is shown the effect of the peak load on the bearing as calculated by varying the load factor "W" in (2). When the load is 4000 lb, the value is again the same, i.e. .000433 in. as on Fig. 3 for 180 deg.

Taking the calculated clearance at face value, the minimum squeeze film is of the approximate order of magnitude of the hydrodynamic oil film. And it means that with a total diametral clearance of .002 in., the bearing will always have approximately .0005 in. squeeze film and that the center of the journal will describe a .001 in. diameter circle within the .002 in. diametral clearance without the benefit of a classical hydrodynamic film generated by inclined surfaces.

New Plastic Laminate

(*Continued from page* 37)

(3) Extreme care must be exercised in building up laminates to see that the fibers are laid in the proper direction, because the unidirectional Conolon fabrics have 100 per cent of their strength concentrated in one direction so that any error in laying up the cloth will result in a seriously weakened product.

(4) Excessive temperatures must be avoided in curing the C and FC types.

(5) The molds must be designed to withstand the pressure involved in curing Conolon. Although they are comparatively low, such pressures may constitute a very large total force which will cause distortion on sizable molds.

A series of tests were recently made to determine whether Conolon laminations could be cured by means of high frequency heating. Good results were obtained, although the tests were not exhaustive, and it now seems possible that Conolon airplane parts will eventually be mass-produced with radio frequency equipment. Despite the fact that it has a specific gravity of only 1.64, Conolon can develop maximum tensile and compressive strength of 120,000 and 56,000 psi, respectively, and a maximum modulus of elasticity of 4.7×10^6.

The cost of Conolon is currently rather high, ranging from $1.58 to $3.93 per square yard, depending on the desired thickness; and, for this reason, the new material is being used only for the fabrication of the more intricate airplane parts, such as ducts and contoured wing surfaces, whose construction with metals would require excessive investments in time, tools, and labor. When the cost of Conolon components has been reduced, it is possible that the laminate will be used to fabricate entire airframes.

Because it has tremendous resistance to vibrations, Conolon is particularly desirable for the construction of airplane parts. In a recent test, the trailing edge overflap of a Liberator B-24 wing was molded from Conolon and placed on a vibrating table. Although the laminated part was lighter than a similar aluminum part, the overflap showed no signs of failure after 55 hours of testing. A dural overflap would have been completely useless after a test of this type.

Some plastic laminates have an undesirable tendency to absorb moisture and deteriorate when subjected to salt water and various other liquids. Conolon specimens have been immersed in salt water, benzene, aromatic fuels, and acetone for periods ranging from 24 to 48 hours without signs of deterioration.

Metal and fabric airplane wings lose a certain amount of efficiency after prolonged periods of operation, due to scratches and mars made by small stones and other debris which are encountered while taking off or landing. Conolon wing surfaces are not subject to this loss, because they can withstand an impact of 120 ft-lb/in.[a]

In most chemical and physical properties, type F is slightly superior to the other types of Conolon. However, the C type is frequently used because of its extreme stiffness. The FC type represents a compromise, and it has some of the good properties of both the F and C types.

Physical Properties of Conolon

Maximum modulus of elasticity	4.7×10^6
Maximum tensile strength	120,000 psi
Maximum compressive strength	56,000 psi
Ultimate bearing strength	82,000 psi
Specific gravity	1.64
Curing pressure	10-15 psi
Curing temperature	275-500 F.
Curing Time	10 min. @ 400 F.
Resistance to ordinary acids, alkalies, and solvents	Good
Resistance to water, oils, and cutting compounds	Good
Maximum Rockwell hardness (M-scale)	110
Maximum impact resistance (edgewise)	126 ft. lbs./in.[a]
Resistance to vibrations	Excellent
Normal Color	Orange
Finish	Smooth, glossy

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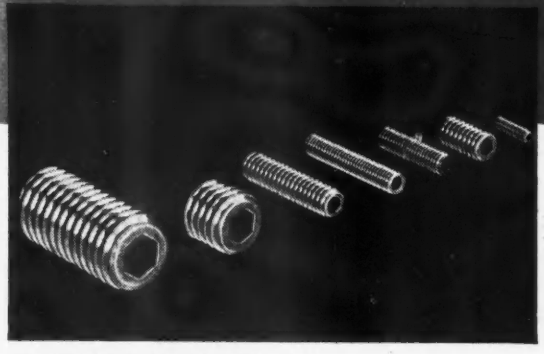

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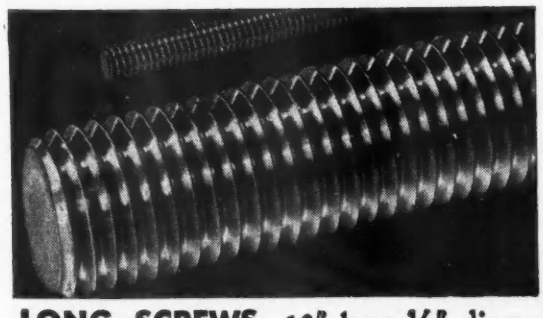

LONG SCREWS—12" long ¼" diameter screws 20 pitch in one pass and 6" long, 1" diameter screws 8 pitch in two passes.

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Measurement of Maneuvering Loads

(*Continued from page* 21)

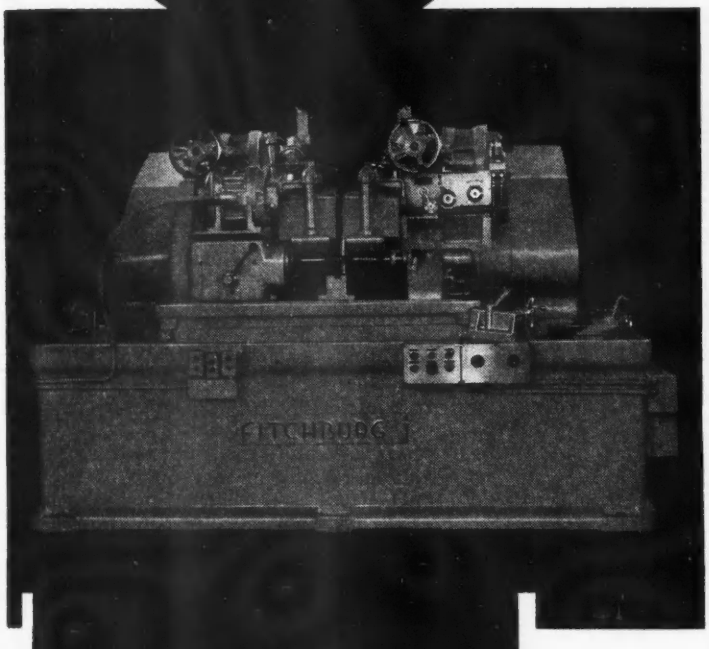
of aileron control force. The points were obtained from a large number of roll tests made over the complete speed range, with right and left, and starting and stopping rolls. The scatter is admittedly large but when it is considered that two different pilots did the testing, and they rolled the ship as hard as they could at each airspeed, it is not unreasonable. The line corresponds roughly to the upper limits. However, if the maneuvering stress is divided by the dynamic pressure and plotted against rate of change of wheel moment no correlation is revealed.

In order to investigate the effect of speed on the maneuvering stresses resulting from rolls, Fig. 3 was plotted. This figure shows the maneuvering stress vs. indicated airspeed. Here a reasonable correlation is found. There appears to be a consistent variation between the maneuvering stress caused in starting the roll compared with stopping it, stopping being higher. This is probably to be expected since in stopping the roll the force on the aileron helps the pilot return the surface to neutral, whereas it opposed when starting. Then there is also the psychological effect on the pilot, he feels he is causing more load on the structure when he suddenly deflects the surfaces than when he suddenly returns them to neutral.

After studying Figs. 2 and 3 it is apparent that maneuvering stresses due to rolls are influenced just as much by the rate of application of control movement as by the airspeed at which the maneuver was made. This brings out one of the most difficult problems connected with the calculation of maneuvering loads and that is they are dependent upon the behavior of the pilot. When looking at Figs. 2 and 3 it should be remembered that the balancing stress or non-accelerated flight stress changes with speed so that the most critical stress (balancing plus maneuvering stress) on the structure will still, in general, be at the highest speed. In this particular case the higher the airspeed the more critical is the stress in the rear shear beam, since for a given roll maneuver the balancing stress increases with speed. Likewise, a roll while in a high speed pull-out or tight turn will produce large total stresses (see Fig. 1).

One of the quantities of considerable interest in roll tests is angular acceleration. In Fig. 4 a plot of rate of change of aileron control force versus angular acceleration is shown. Here again considering the large number of variables a good correlation is obtained. From this figure it can be said that the angular acceleration must be governed just as much by the rate of change of control force as by airspeed.

(*Turn to page* 72, *please*)



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(*Continued from page* 70)

Pull-Outs

In addition to the measurements during roll tests, some measurements of tail load during pull-outs have been made to determine what the maneuvering increment of tail load would be on a P-38 airplane during a pull-out from a dive.

The oscillograph and automatic observer installation was identical to that used during the roll tests. Strain gages were used for measuring boom bending moments, elevator hinge moment, elevator stick force, elevator angle and C.G. and tail acceleration. The strain gages used in measuring the boom loads were calibrated directly in terms of bending moment by loading the stabilizer at a given location. Measured boom moments were corrected for the effects of acceleration loads on the structure before calculating tail air loads.

In order to check up on instrumentation and technique of making tail load measurements, balancing tail loads for steady flight conditions were measured throughout a wide range of airplane speeds. The results obtained are shown in Fig. 5. Plotted on the same figure is a tail load curve calculated from wind tunnel data. The two curves compare very well except at the higher speeds. Both the calculated curve and the experimental points are for constant power, thus the higher speeds had to be obtained by dividing the airplane. This may have had some influence on the measured values, however, the discrepancy at the higher speeds is probably due to inaccuracies in the wind tunnel tests or Mach's number effect.

Load history curves of two pull-outs are shown in Figs. 6 and 7. Fig. 6 represents a relatively easy pull-out, whereas Fig. 7 represents the most severe pull-out made during the test program. Note that there is no definite increment of down tail load evident in Fig. 6, but in Fig. 7 the down tail load increased 360 pounds just prior to the start of the C.G. acceleration increase. Unfortunately during the hard pull-up tail accelerations were not obtained thus the corrections to the measured boom moments had to be made on the basis of C.G. accelerations only. This results in a smaller increment of down tail load of approximately 200 to 300) pounds. The results of five pull-ups including the two mentioned are given in Table I. The values tabulated are rate of application of stick force, rate of elevator deflection, rate of C.G. acceleration build-up, indicated airspeed, and maneuvering increment of tail air load. Tail acceleration measurements were not obtained for the last three pull-outs listed, thus the maneuvering increment of tail air load is somewhat low.

Table I

VI MPH	Average Rate of Stick Force Application Lbs./Sec.	Average Rate of Elevator Deflection Deg./Sec.	Average Rate of C.G. Acceleration Build-up G's/Sec.	Maneuvering Increment of Tail Air Load Lbs.
410	30	1.3	1.1	...
300	45	3.2	1.1	...
246	200	11.0	4.0	320
275	230	9.0	4.5	280
322	330	11.0	9.0	360

The first two pull-outs were fairly gradual and there was no distinct maneuvering increment of tail air load. The next three were quite sharp, but the maneuvering increment of tail air load were small. Due to elasticity in the system it is doubtful if pull-outs much more severe than the last one listed (also see Fig. 7) could be made. The total maximum down tail load (maneuvering increment plus balancing) did not exceed 20 per cent of the calculated limit maneuvering load during any of the pull-outs performed. Apparently the design requirements on maneuvering tail loads are overly conservative for this airplane.

As mentioned in the introduction, maneuvering loads on the horizontal tail surfaces of large airplanes is currently of particular interest. The addition of special tabs and booster control systems has greatly added to the importance of accurate calculations of maneuvering tail loads. One of the problems which must be answered for large airplane design is whether or not

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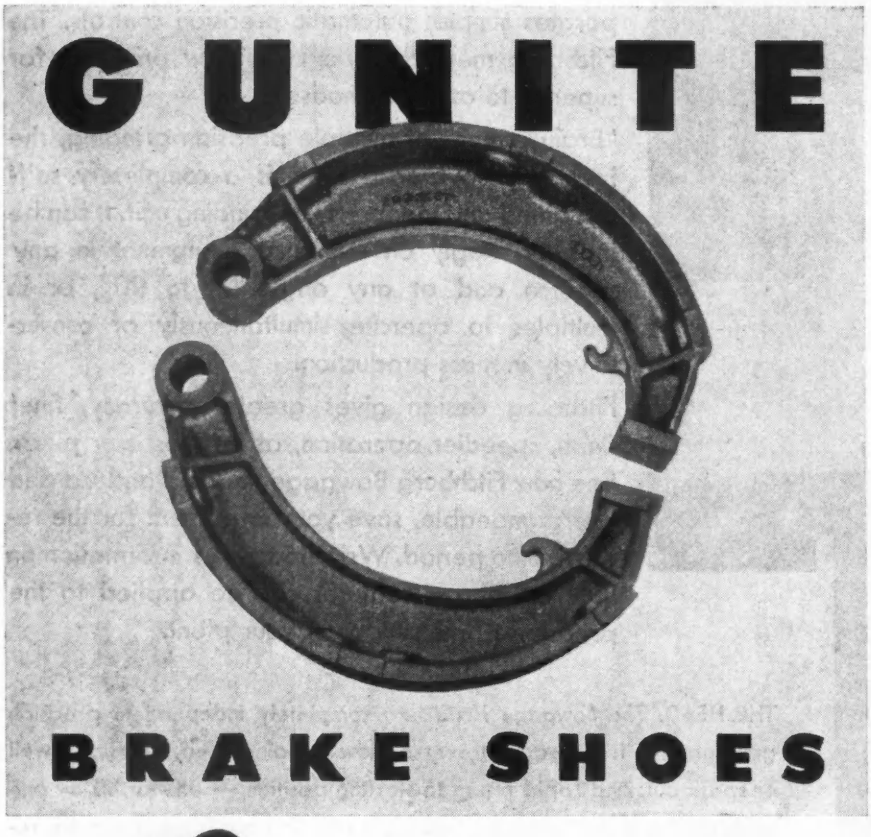

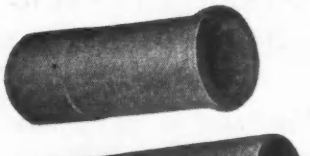

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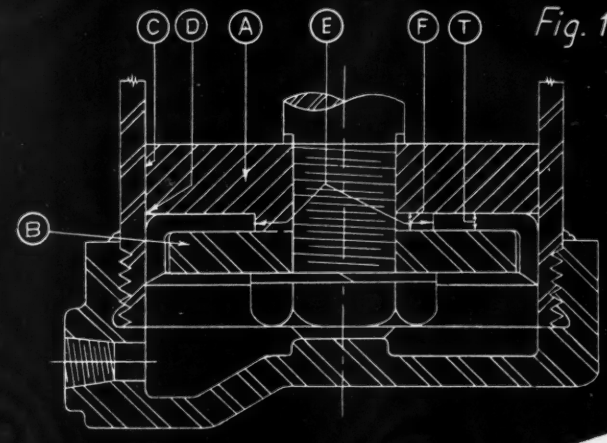

Fig. 1

Present

No. 8

Proper Design of Backing Plate for Cup Packing

PURPOSE. The purpose of a backing plate on a cup packing application is to give the packing adequate support. In many cases, the backing plate (A in Fig. 1) is also the piston head.

THICKNESS. The backing plate must be heavy enough to support the maximum pressure anticipated for the application without becoming distorted. This same factor will also influence selection of the type of material used for the backing plate.

In applications such as Fig. 1, where the backing plate is apt to bear on the cylinder wall during travel of the piston, the thickness of the backing plate should be great enough to provide suitable bearing surface and thus minimize wear both on itself and on the cylinder wall.

CLEARANCE. Clearance at C should be a workable minimum. Wide clearance invites extrusion of the packing, resulting in breakdown at the heel. In most cases, the backing plate should be a close sliding fit in the cylinder.

The circumferential edge at D, where the heel of the packing is supported, should not be rounded. It should be dressed with very fine emery cloth (crocus cloth preferred) just enough to remove burrs left from machining.

Close clearances plus a good square corner will prevent extrusion of the packing.

In general, diameter of the hub (E) should be as small as possible (particularly when using a small diameter cup) so that the bottom of the cup will be wide enough to be held securely.

Height of the hub (F) should be less than the thickness (T) of the leather in the cup packing—15% less for a very hard packing, 20% less for a soft packing. This allowance permits compression of the bottom of the cup to create the required seal between the packing and the piston head. Excessive compression —which would spread the packing—is prevented by the hub.

(In the absence of a hub, the bottom surface of the backing plate is usually fluted to assist compression sealing and prevent the packing from spreading. Simple hand sprayers, pitcher pumps, etc. do not require fluting, but when the cup bottom must be bolted or held by a follower, fluting is desirable.)

*Thickness of follower plate (B) should be enough to fill the space between the bottom of the cup and the inside bevelled edge of the lip.

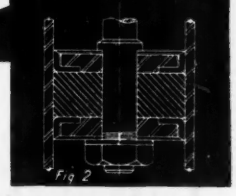
Fig. 2

Fig. 2 shows two cup packings installed back to back in a double-acting cylinder. In such cases, a common backing plate is necessary.

BACKING PLATE FOR DOUBLE-ACTING CUPS

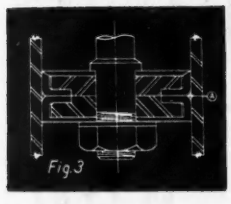
Fig. 3

Notice in Fig. 3 that neither cup is supported over the area A other than by the opposite cup. No cup packings should ever be installed back to back without a backing plate between them.

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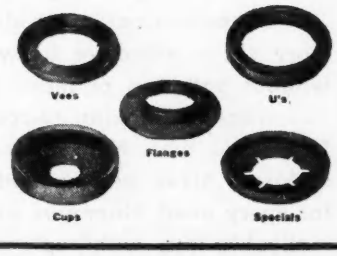

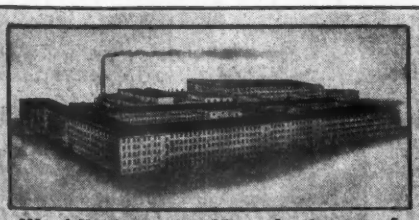
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the pilot will recognize the severity of a maneuver which will result from a certain control deflection.

In order to obtain some preliminary information on this general problem, structural loads were measured on the Constellation airplane during some maneuvers. This airplane is a large, fast transport which incorporates the latest developments in control systems and maneuverability.

Fig. 8 shows a photograph of an oscillograph record made during a sharp 2 "G" turn. This maneuver was made by an experienced pilot when requested to make a sharp turn during a test flight. The major vertical lines in the photograph are timing lines and represent tenth-second intervals; the fine lines are hundredth-second intervals. As is evident from the nature of the traces the quality of the record is good and the general spread of the traces is such that no difficulty was encountered in interpreting the record.

Fig. 9 shows a plot of the stresses and loads obtained from the oscillograph record of Fig. 8. In Fig. 9 the elevator stick force curve is interesting since it shows a rate of application of force of 390 pounds per second which slightly exceeeds that obtained in the most severe pull-out in the P-38 described previously. Note that there is a lag between the stick force and the elevator hinge moment whereas in the P-38 pull-outs there was no lag. This small lag is probably due to the operation of the control system since a certain quantity of oil must flow in the boost system. A reasonable explanation for the greater rate of force application for the Constellation is that during part of the stick force build-up the elevator was not deflecting, thus the stick deflections were probably small whereas in the P-38 the elevator deflected almost immediately with application of the stick force thereby permitting relatively large stick deflections.

From a maneuvering load standpoint the lag or elasticity in a control system is very significant because abrupt actions by the pilot are not immediately reflected in the elevator load and position. Thus any calculations of maneuvering tail loads made on the assumption of specified pilot action will have to take into account the operating characteristics of the control system. This is particularly true on large airplanes.

The maneuvering increment of tail air load obtained in the sharp turn by the Constellation was 6000 pounds. This is approximately 30 per cent of the calculated maneuvering increment used in design of the airplane, although the maneuver was not the most severe that could be performed based on the center of gravity acceleration (could have been 1.86 times as severe) it does not seem likely that one three times as severe could be made. Thus, it appears that for this airplane the design criteria for maneuvering tail loads is conservative.

(*Turn to page 76, please*)

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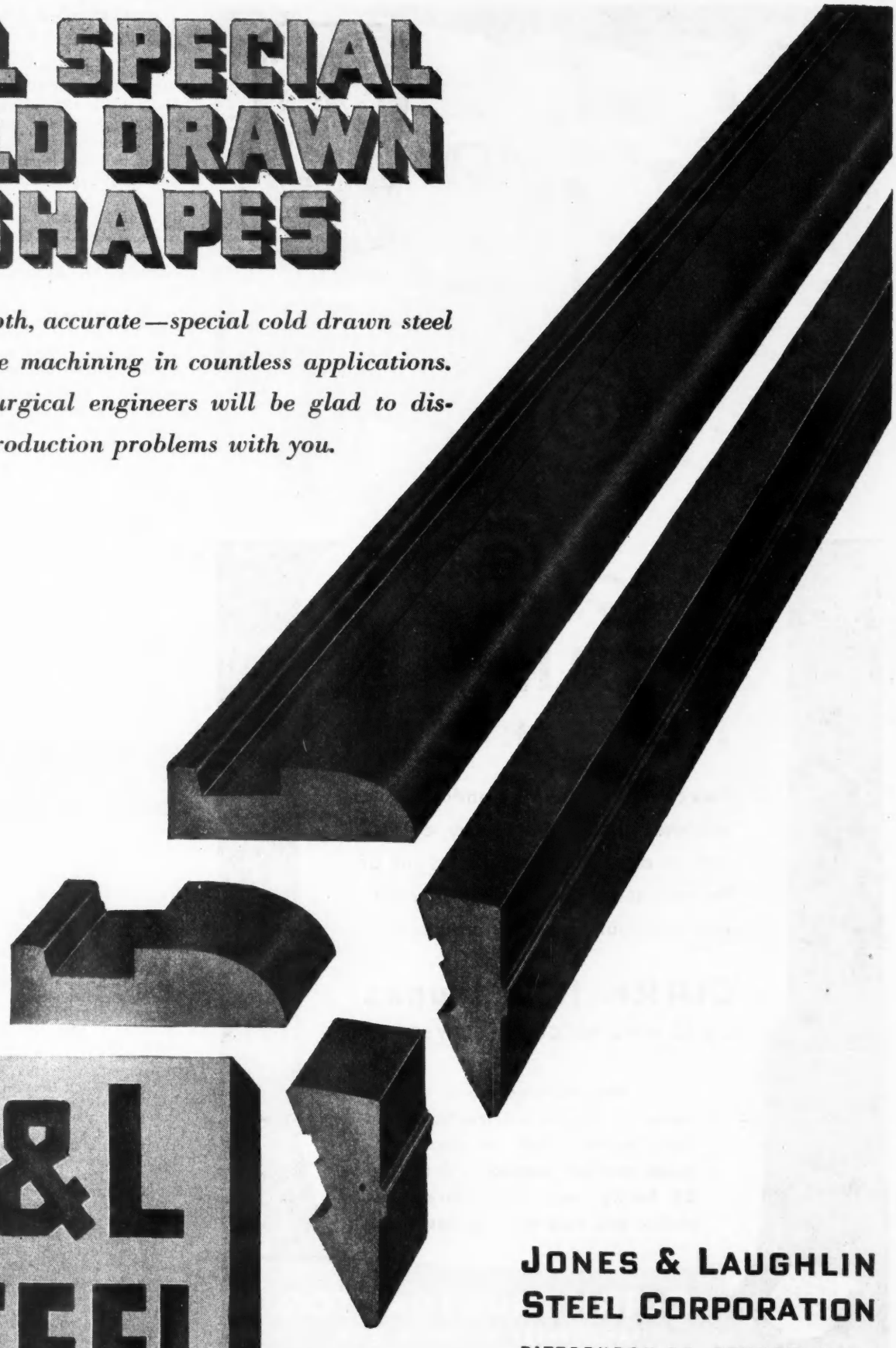

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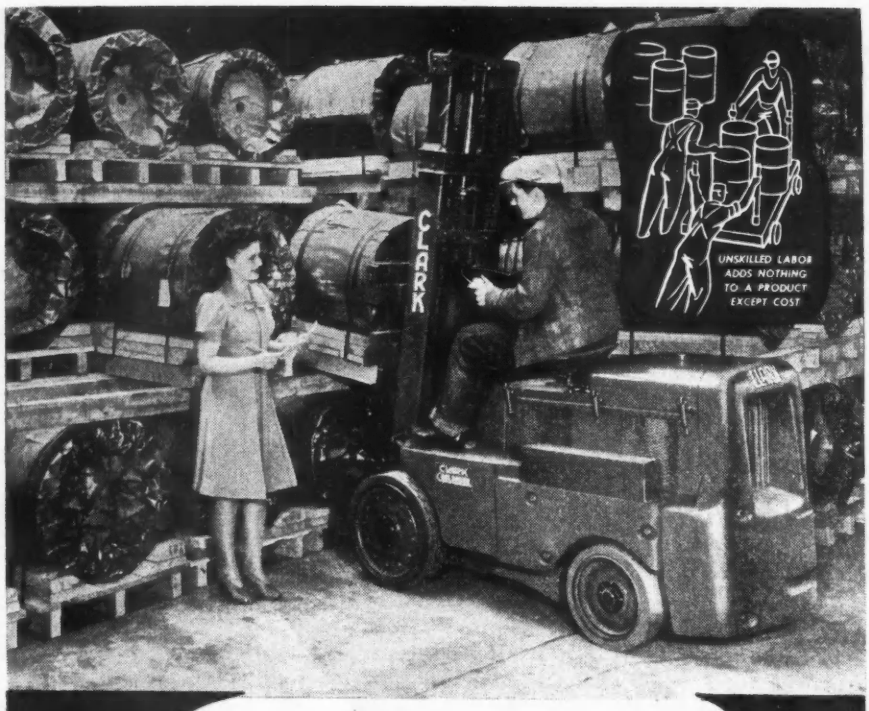

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(*Continued from page 74*)

Conclusion

From the structural flight test measurements described and many others made at Lockheed Aircraft Corp., the following conclusions can be drawn: the technique of measuring loads in flight has developed to the point where accurate reproducable results can be obtained. Valuable design information and high speed, full scale checks on wind tunnel data can be secured. Flight measurements can definitely tell what members in redundant structures become critical under maneuvering conditions as well as the magnitude of the applied loads.

In general, the maneuvering loads resulting from sudden control surface deflections show that they are as much or more a function of the rate of applications of control force as the airspeed. Maneuvering tail loads obtained in flight on both a P-38 and the Constellation show that during sudden pull-ups the loads produced are small as compared to those used in design.

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1. W. W. Beman and C. E. Frost, "A New Criterion for Loads in Pitching Maneuvers." Paper given at Pacific Coast 1944 June Meeting of Institute of Aeronautical Sciences.

2. H. B. Dickson, "Maneuverability and Control Surface Strength Criteria for Large Airplanes." Journal of the Aeronautical Sciences, September, 1940, Vol. 7, No. 11.

PERSONALS

Recent Appointments Among Automotive and Aviation Manufacturers:

Pontiac Motor Div., **Donald Stuart,** Asst. Parts and Accessories Sales Mgr.

Chevrolet Motor Div., General Motors, **T. F. Brown,** Asst. Gen. Sales Mgr., charge of parts and accessory merchandising, warehousing and distribution.

Ford Motor Co., **L. W. Smead,** Asst. Branch Mgr. Buffalo Branch; **R. A. Pankopf,** Asst. Branch Mgr., Somerville, N. J.

Burgess-Norton Mfg. Co., **C. Wohlhuter,** Vice-Pres., and **W. T. Crane,** Asst. to President.

General Motors Corp., **W. G. Lewellen,** Director, Distribution Staff and Chr. Distribution Policy Group.

The Goodyear Tire & Rubber Co., **E. J. Thomas,** Pres. appointed regional vice-pres. Natl. Assoc. of Mfrs. Goodyear Aircraft Corp.; **C. M. Van Epps,** Asst. Gen. Mgr. of Goodyear-Australia.

Lempco Products, Inc., **J. H. Gulick,** Gen. Factory Mgr., Bedford, O.

Graham-Paige Motors Corp., **Vern R. Drum,** Vice-Pres. and Gen. Mgr., Warren City Mfg. Co.; **Raymond J. Fitness,** Vice-Pres. and **John S. Slick,** Asst. Secretary and Asst. Treas. of parent company.

Bound Brook Oil-Less Bearing Co., **W. R. Toeplitz,** Vice-Pres. Chg. of Engineering Research.

Progressive Welder Co., **Boyd V. Giesey,** head of Flash Welder Div.

The Timken Roller Bearing Co., **O. J. Hoger,** Chief Engineer of Railway Div.

Wheelco Instruments Co., **Emery J. Stevenson,** Sec.-Treas.

The Briggs Clarifier Co., **Charles W. Miller, Jr.,** Member of Engineering Staff; **A. M. Andrews,** veteran pilot, Commercial Airline Service.

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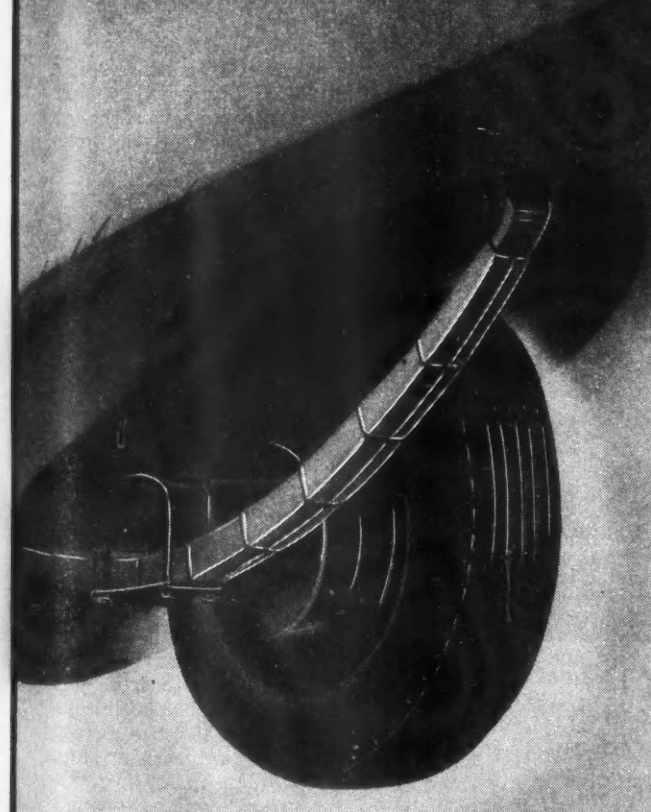
Par for Smooth Driving



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Government Coordination Lacking

(*Continued from page* 17)

ology in contracts, orders, directives, rules, or regulations which might possibly be interpreted by field representatives as prohibiting release of company-owned equipment from war work. Or, what would be even better, they should issue a simple and direct policy statement waiving any restrictions now existing on recapture of such tools. In either event, one more important step would be necessary—to inform all field representatives on the local level, making the policy and attitude on disposal unmistakably clear. A single, clear-cut coordinated statement of policy and procedure, adhered to by all of the Government agencies concerned and implemented by action, should be put into effect at once.

Policies and procedures dealing with disposal of surplus and potentially surplus Government-owned production equipment likewise are conflicting and vague. Negotiations which various companies have carried on have been inexpressibly dreary and fruitless. To date, about the only ones that have had any measure of success are those which put pressure on every step of the process, a thoroughly unwholesome and uneconomic business.

Automotive companies report that purchase of Government-owned machines in their hands has been pretty much a dead letter, because of the general resistance of the military services to sale of equipment to the contractor in possession unless it is continued on war work. While such a policy was defensible earlier in the war when tooling was still largely uncompleted and new contracts were piling in, it no longer is tenable when production is trending downward. The need is to sell equipment—that is idle or soon to be idle—*now* so that reconversion can get under way and large-scale unemployment averted as much as possible. It is time now to catch up the strings that were dropped in panic last fall when the Belgian breakthrough halted all reconversion planning. At that time, a "soft freeze" on machine tools effectively stopped any chance of their movement into reconversion channels. Late in May the Surplus Property Board announced that it had adopted regulations governing sale of machines to contractors in possession. The regulation, however, does not take care of machines which are not in possession of the war contractor. It is true that the Reconstruction Finance Corp. will sell items that already have been declared surplus, but the greater number of Government machine tools inhabit a sort of No Man's land where they have not been declared surplus—even though idle—and therefore cannot be purchased.

Another factor which is slowing reconversion is the dubious restriction which prevents equipment to be sold if it is likely to become surplus within four months—although it can be considered for sale if it is not to become surplus in that period. The peculiar result is the machines which are nearest to being accessible for reconversion are actually the most unobtainable.

The lack of a coordinated, balanced over-all procedure among all procurement agencies for removing surplus and excess equipment from plants represents another example of the need for teamwork. Defense Plant Corp. probably has gone the furthest in this respect. It has lined up warehouse and other storage space in the Detroit area and has engaged a warehousing organization to handle part of the job. It also has entered into negotiations with war contractors who have agreed to undertake processing, moving and some long-term storage on a non-profit basis, since there simply are not enough commercial moving facilities available in Detroit to handle the job in anything like the short time required.

There are, however, many machines which have been put on the surplus as

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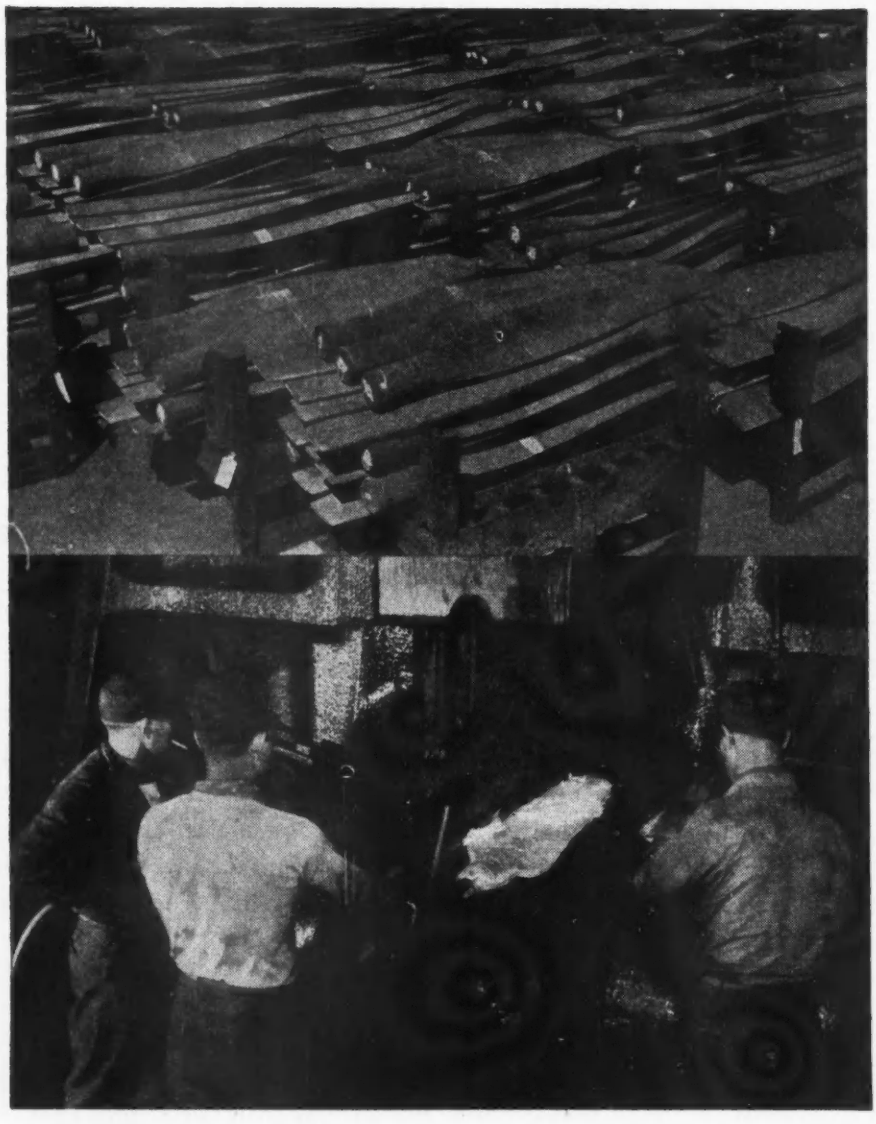

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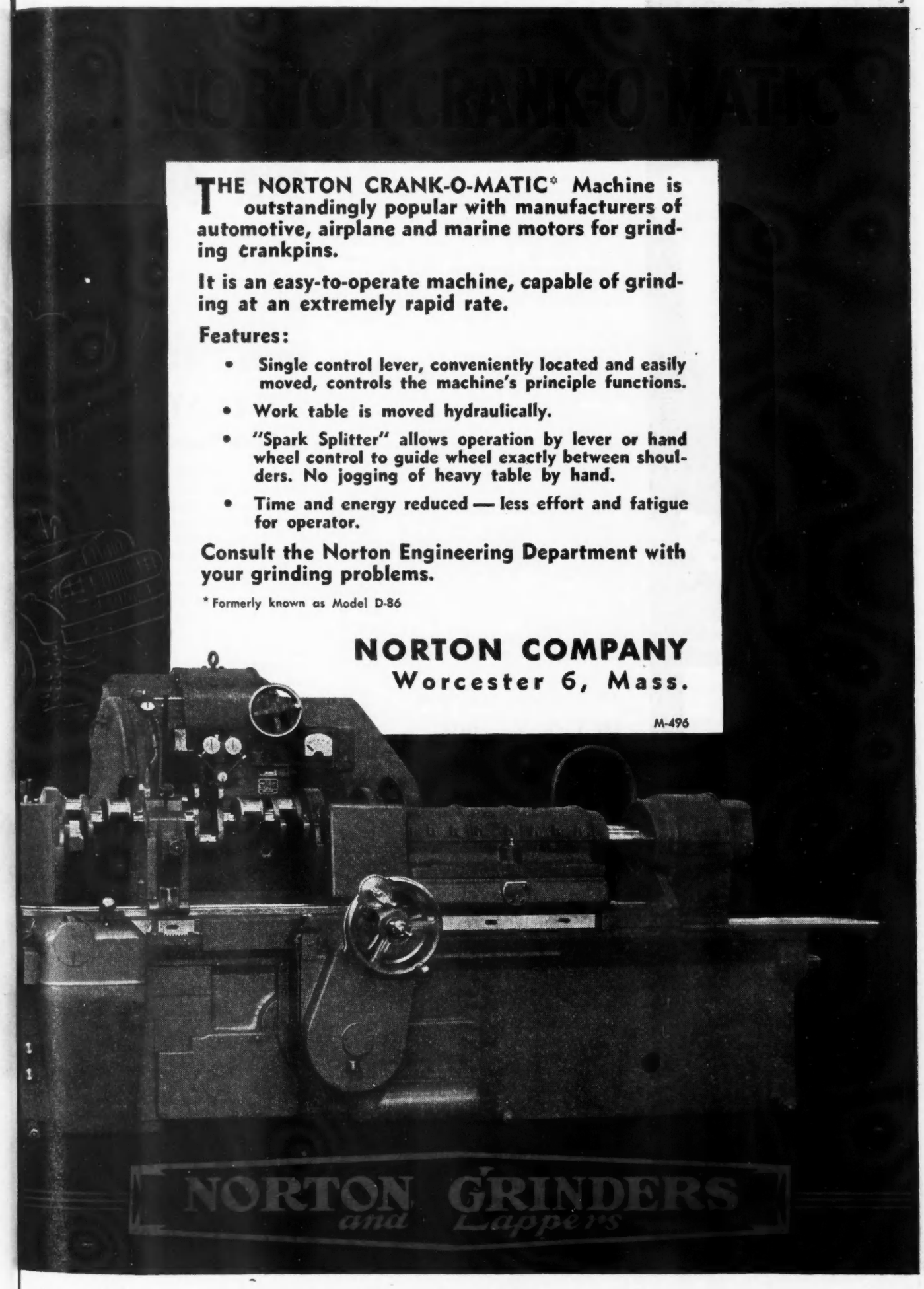

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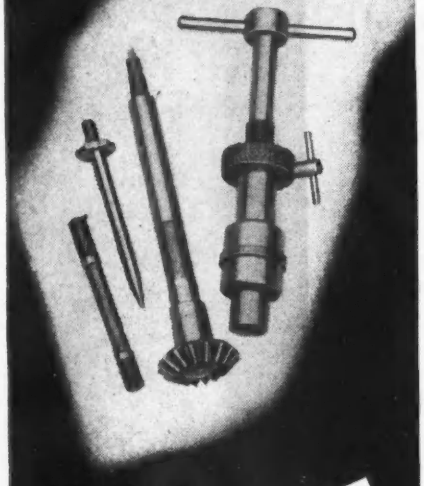

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long as 18 months and which still are cluttering up automobile plants. Contractors have filed multiple copies of surplus equipment lists with the proper owning agencies only to find such equipment "not available" in Government lists and not being followed up.

It is understood that the agencies have at least 60 days to screen lists of surplus equipment against current needs. While this is being done—and sometimes it takes as long as 120 days—the machines are occupying plant space, and other prospective purchasers have no chance to learn about them. Some type of prompt up-to-date uniform listing procedure, which is the same for all agencies concerned, is needed to put the information about available machines into the hands of prospective purchasers so that equipment may be sold and moved out of the plants promptly.

The automotive industry itself could do a noteworthy job in this respect if the Government services would lift the censorship they have imposed, which prohibits contractors from disclosing any information about Government-owned or sponsored equipment in their plants. The industry has asked that all procurement services notify all field representatives that contractors in possession are free to disseminate information about such available equipment to other automotive manufacturers who may need it. The Automotive Council for War Production would act as a clearing house for such an information exchange through the machine tools listing service it has organized to facilitate reconversion.

The Production Side Of Jack & Heintz

(*Continued from page* 25)

should give the reader a better impression of how the job is done at Jack & Heintz.

The majority of first machining operations are made on a Bullard Mult-Au-Matic. This machine is used because of the multiplicity of cuts which can be made without rehandling of individual work pieces. Operations on starter housings on the Mult-Au-Matic include machining the inner and outer sides of the bell form of the housing; facing the motor flange; machining the ID of the grease container bore and of the bearing seat. The concentricity of the motor flange in this operation is held to a tolerance of 0.002 in. The flange face is likewise held to the same tolerance. Gisholt turret lathes are sometimes used on individual operations in this first step, but generally the latter are combined in the Bullard.

From this point the work is taken to the heat treating department where Lindberg Electric furnaces are used, followed by Gleason quench presses which hold the work in dies to prevent distortion. This is followed by washing in an Alvey Ferguson washer to remove oil before the draw. Work is

(*Turn to page* 85, *please*)

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drawn in an Eclipse unit; then routed to the Bullard-Dunn process machine. Here all scale is removed by a series of alkali and acid tanks and washes. This machine is automatic in operation, lifting its load of parts, and rotating it to the next position until the cycle is complete and work can be removed. The work is redrawn to remove hydrogen embrittlement that may have been accumulated in the tanks.

Finish machining after heat treatment is generally done on a No. 5 Warner & Swasey lathe where finish facing is done on flange face, bell face, motor flange, and face of grease retainer bore. Also, in one sequence the ID of the bearing seat and the ID of the bell is bored, machine clutch face is surfaced, and hobbing relief and ring groove cut on the inside of the bell.

The next operation is done on Heald Borematics where a finish cut on the bearing seat to within 0.0005 in. tolerance is consistently turned out. This machine handles two pieces at one time. Then the splines on the ID of the bell are cut on the Fellows gear shaper. This is followed by a drilling operation on a multiple spindle Natco which drills 24 holes in the motor flange. Degreasing follows on a Ransohoff washer. Degreasing is done under pressure, the jets delivering 450 gallons per minute, thoroughly cleaning each piece. The work is then run through a Magnaflux machine to detect cracks and is ready for final shop inspection.

Of the many other parts necessary for the starter, two of them should receive some comment. One part is the commutator clamp produced on a battery of Greenlee automatics. These parts are cut from raw stock; roughed out internally at 45 deg; semi-finished on the angle; rough formed on the OD; finish turned on the 45 deg; finish turned on the OD; bored on the ID; and cut off. Conomatics are used on such parts as blanks for planetary gears for the starter, the operations consisting of drilling and reaming the ID; turning and shaping the OD; roughing out the trepan; finishing trepan; roughing and finishing face; reaming and cutting off. It is highly important that the sides must be square with the OD and very close tolerance is held on this work.

A large battery of Brown & Sharpe millers is used for light cuts on a multiplicity of parts.

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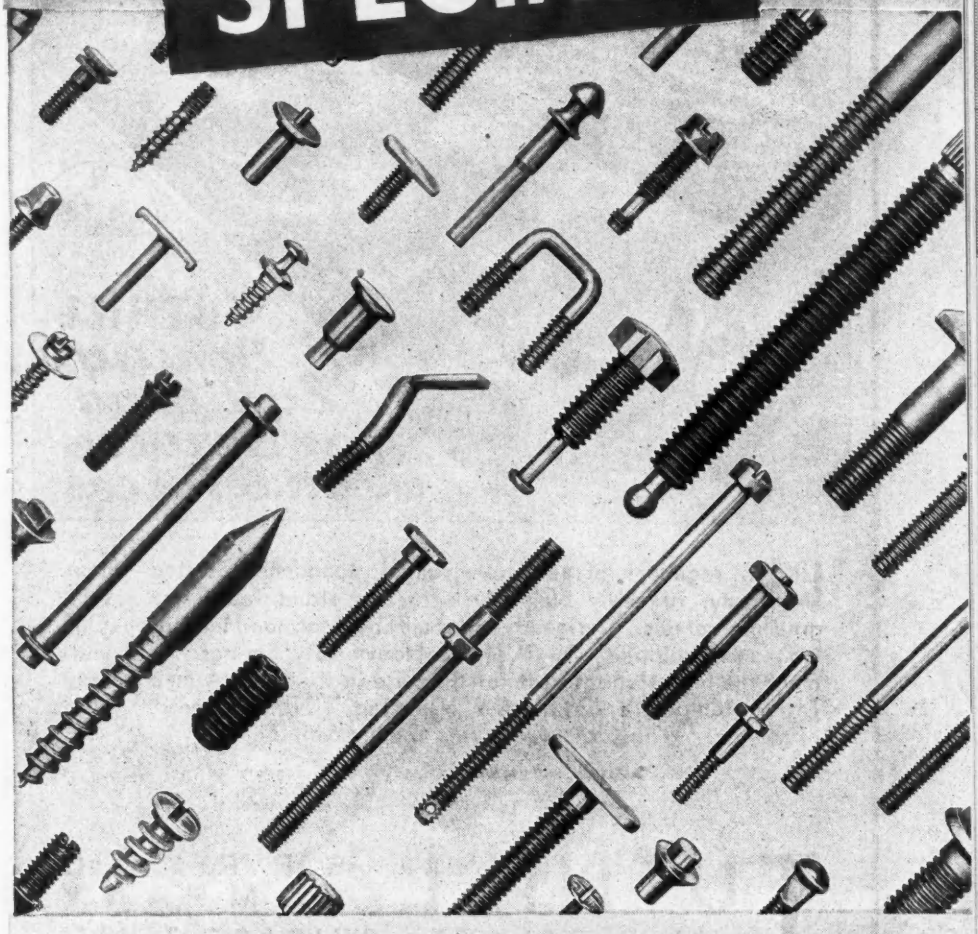
American Chain and Cable Co., Inc., Bridgeport, Conn., has recently announced on behalf of its two wire rope divisions, the American Cable Division and the Hazard Wire Rope Division, that their several types of wire rope slings may now be accompanied by a Certificate of Test and Registry for the benefit of the sling user. The policy of selling Registered slings is new to the wire rope industry.

HOLTITE SPECIALS



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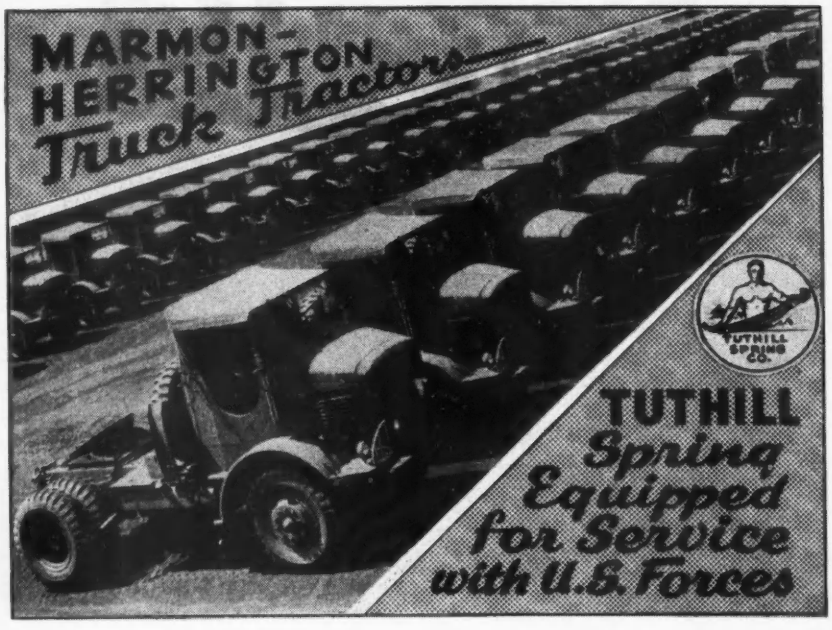

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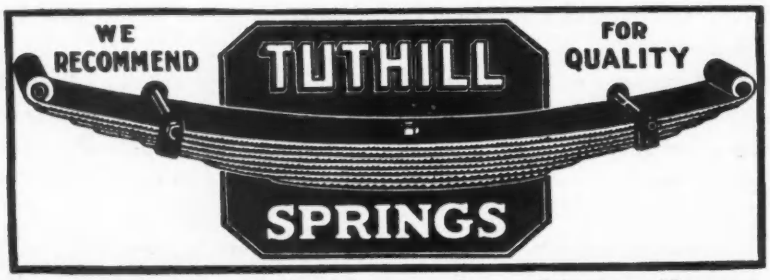

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Synthetic Rubber Parts

(*Continued from page* 31)

position to take up any slight wear.

In contrast to the high temperature while the vehicle is in motion, the seal also is exposed to frigid temperatures at the coldest Arctic base where Jeeps are used. Under these conditions—constantly exposed to oil in extreme heat and cold—the seal must retain its flexibility and correct size if it is to function satisfactorily. It must perform under these conditions for the life of the shock absorber which is of "built-in" construction. There is no provision for disassembly for repairs or replacement.

Two other applications are found in products of Jack & Heintz, Inc., and Thompson Products, Inc. On its automatic pilot, Jack & Heintz wanted to avoid the use of copper for a drain tube because metal tubing would require fittings. The fittings would require more manpower in manufacture of the drain tube itself and additional manpower in the assembly of the tube

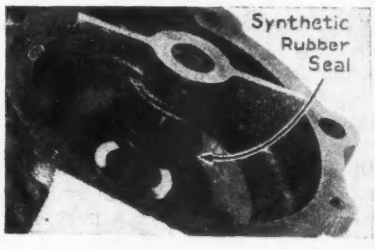


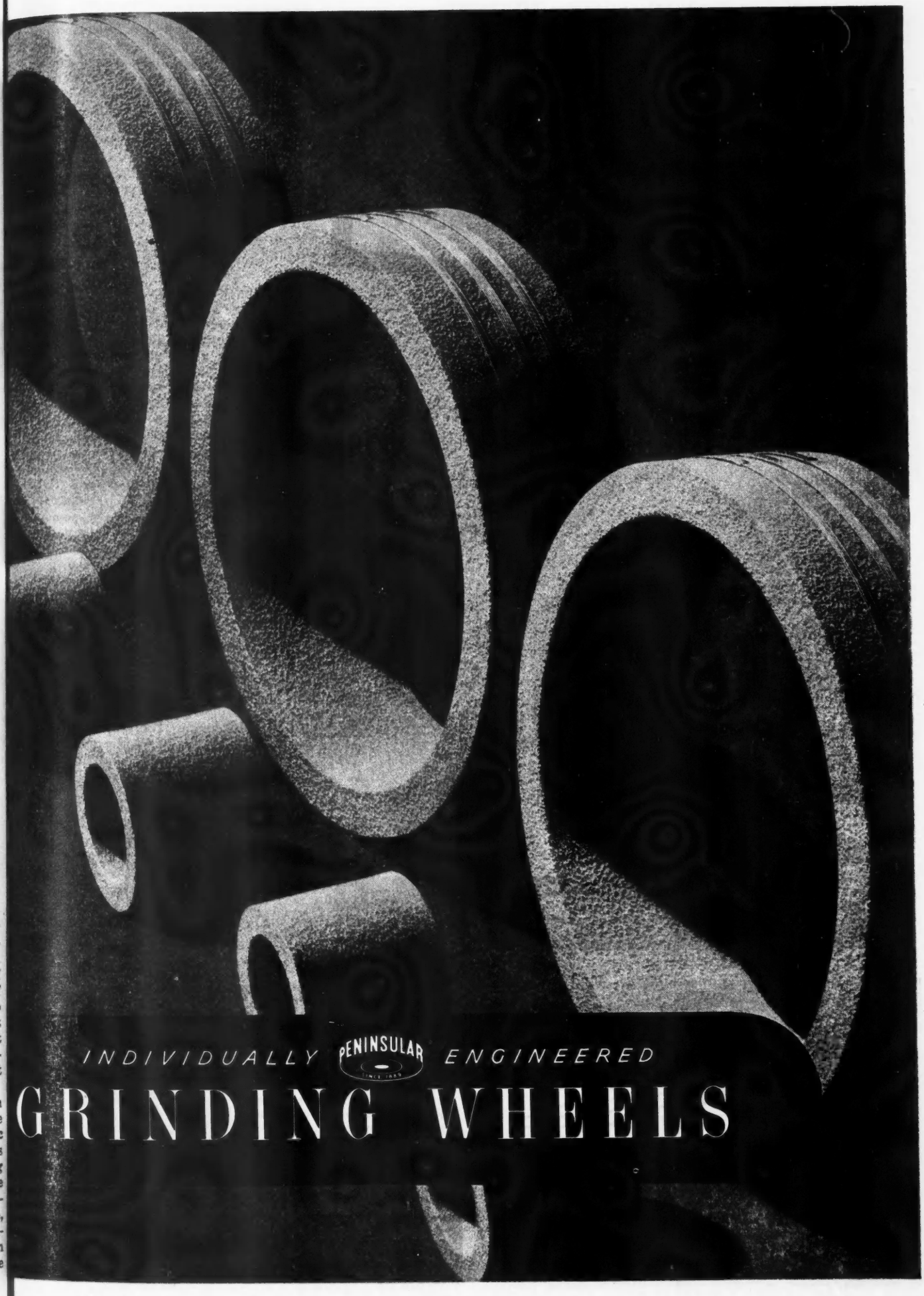
Fig. 3—Water pump is process of assembly. Synthetic rubber seal in operation is flush against sealing surface on housing.

in position. However, copper appeared to be the only material which could withstand the hydraulic fluid, an asphaltic-base oil, used in the system.

The solution to this problem was to make the elbow-shaped tube from a highly oil-resistant synthetic rubber. Hycar was chosen in this application because, in addition to its high resistance to oil without excessive swelling or shrinking, it could retain its characteristics under extreme temperatures. The permissible limits of shrinkage of the drain tube are 3 per cent and of swelling, 5 per cent. The tube also must have excellent permanent set characteristics since to save weight it is attached under a 60 per cent transverse stretch so that clamps to hold it in place are unnecessary.

The drain tube carries the return flow of the hydraulic fluid from the balanced oil valve of the automatic pilot to a manifold. Some vibration is possible at this point, so the tubing must remain flexible at the extreme temperatures to which it might be exposed, 185 F down to —70 F. Also, deterioration caused by oil at any temperature in this range would result in particles from the tube entering the

(*Turn to page* 90, *please*)


INDIVIDUALLY PENINSULAR ENGINEERED
GRINDING WHEELS

hydraulic system with subsequent failure of the device in its accurate operation of elevators, ailerons and rudder.

The tubing is tested for flexibility by soaking it in the asphaltic-base oil and winding it around a 1-in. diameter rod at —70 F. The heat resistance test consists of subjecting the tubing to a temperature of 300 F for five hours and 250 F for 24 hours. The tested part must show no more than a 5-point change in Durometer hardness, and must not lose more than 15 per cent of its original tensile strength and elongation.

In the case of the automotive water pump made by Thompson Products, Inc., the special-purpose synthetic rubber used in the seal—like that in the shock absorber. The location of the seal in the water pump in shown in Fig. 3. This type of pump is replacing the type which is packed with graphited asbestos and which has screws on each side of the shaft for periodic tightening of the packing. The new pump eliminates the conventional packing and the possible error of drawing up the packing too tight or not tight enough and the potential leakage, no matter how well packed. The demand for this improved type of pump may be better realized when it is stated that Thompson Products made 200,000 of the new pumps for replacement on one year's model automobile.

In explanation of the pump shown in Fig. 3, the rotating shaft driving the pump must pass through the cooling liquid but no liquid must be permitted to enter the bearings of the pump nor leak out to deplete the system. The synthetic rubber seal fulfills this leakproof requirement. The seal fits tightly on the shaft and has two notches at the circumference which fit into the pump impeller so the seal will rotate with the shaft. One side of the seal is a flexible bellows which is exposed to the cooling liquid, while the face has a graphited surface, which seals against a cast iron housing having a sealing surface machined to nearly an optical finish.

The purpose of the bellows is to keep the flat, graphited face of the seal flush

(*Turn to page 92, please*)

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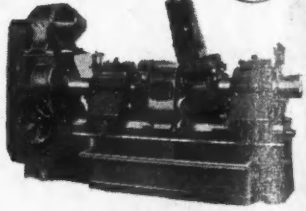

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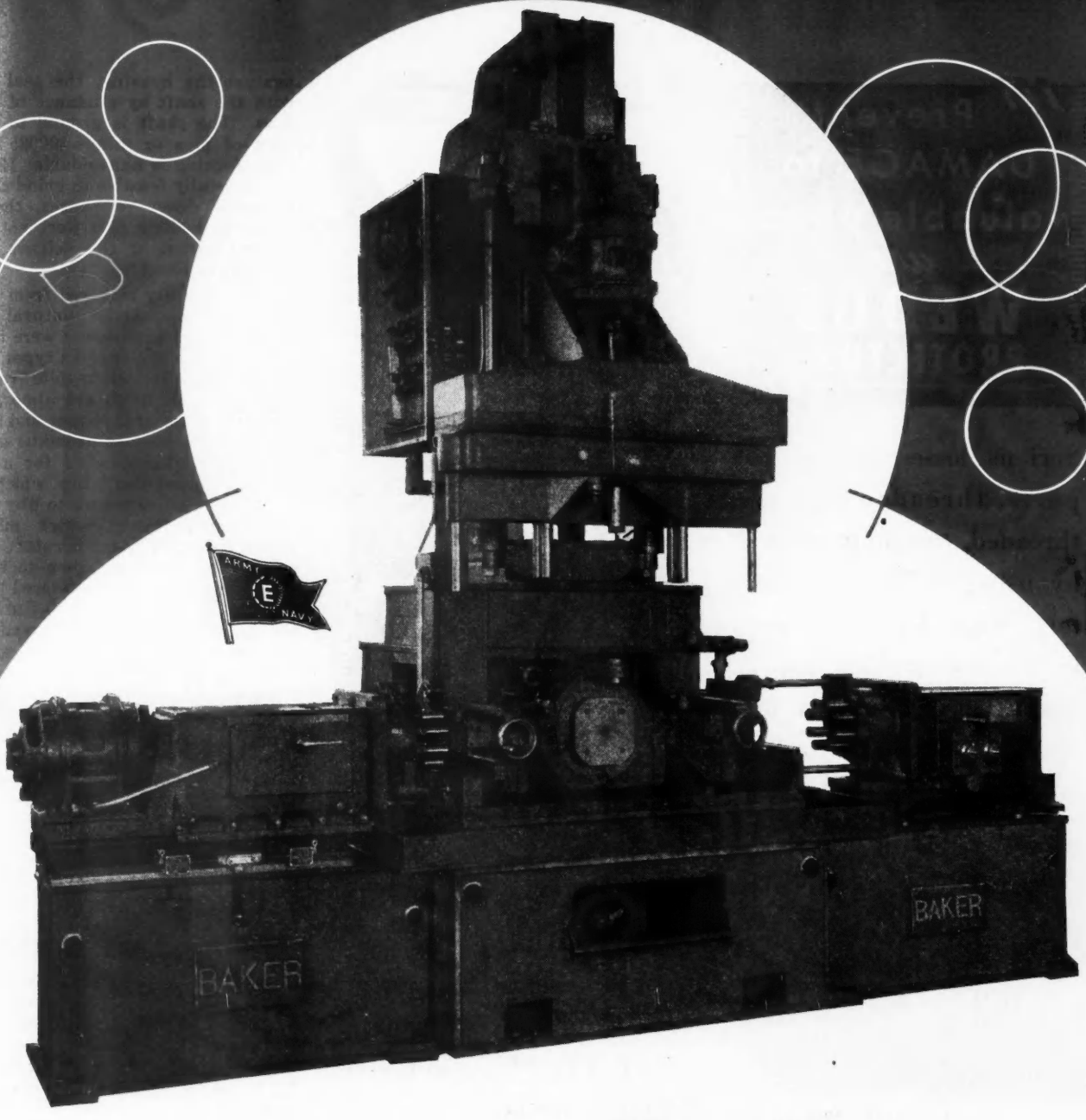

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Four Way
Multiple Spindle
DRILLING MACHINE

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Fortunate, indeed, will be the manufacturers who are tooled with BAKER automatic cycled Multi-operation machines when they must reconvert, because BAKER machines are flexible and can be quickly converted to Peace-time requirements.

Ask Baker Engineers to help solve your drilling, boring and tapping problems.

The illustration above shows a BAKER machine set up to drill the large size pipe tap hole with the center spindle, two holes at each side of the center spindle and one each end of the other drilling operations. The vertical unit mounted on a straddle frame allows for the mounting of another BAKER 7½ A 14 self-contained hydraulic feed unit in the rear at right angles to the two side units. The rear horizontal unit has eleven spindle heads for drilling ten holes in the banjo surface and one hole to right. Control panel high off the floor mounted on side of vertical frame—Fully automatic in its cycling—started by means of push button station convenient to operator.

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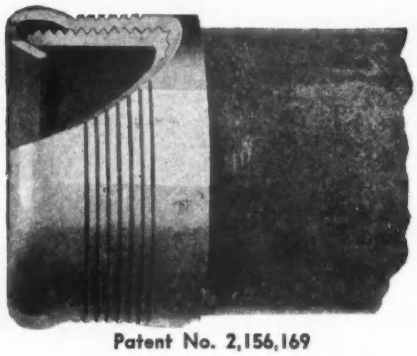
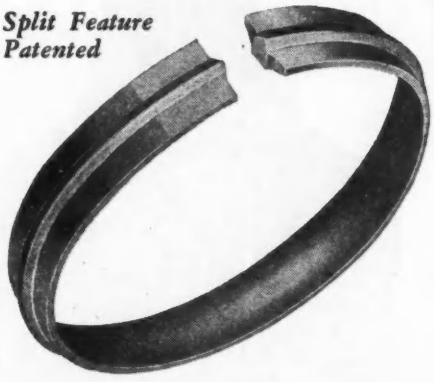


Patent No. 2,156,169

Split Feature Patented



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against the housing, the seal rocking with the shaft by guidance of the bellows. The shaft is ground to a tolerance of plus or minus .00025 in., but some rocking is unavoidable. If it were commercially feasible to grind the shaft to much closer tolerances, there still would be leaking if it were not for the flexible action of the bellows holding the seal in exact position.

The flexibility required from the seal bellows would make natural rubber ideal for this application were it not so vulnerable to the various types of anti-freeze used in automobile radiators. Some of these fluids are almost as destructive to natural rubber and to many synthetic rubbers as aromatic gasoline. The specifications called for a rubber seal with good flexibility which would be retained on exposure to any type of anti-freeze solution which might be used, whether the temperature was at the boiling point or down to the sub-zero temperatures encountered in many parts of the country. Ohio Rubber met the specifications by compounding the seal from Hycar oil-resistant synthetic crude rubber.

These three applications for synthetic rubber illustrate some of its uses other than for tires. It should be pointed out, in addition, that there are various types within this special-purpose group of synthetic rubbers. They have varying degrees of oil-resistance together with other properties which also vary widely.

New Progressive Welder Representative

The formation of Aulerich and Grimes by A. J. Aulerich and Wm. F. Grimes to represent Progressive Welder Company, Detroit, in the Western Ohio industrial area has been announced by E. J. DelVecchio, field sales manager of the company.

Climer Now Member of WLB

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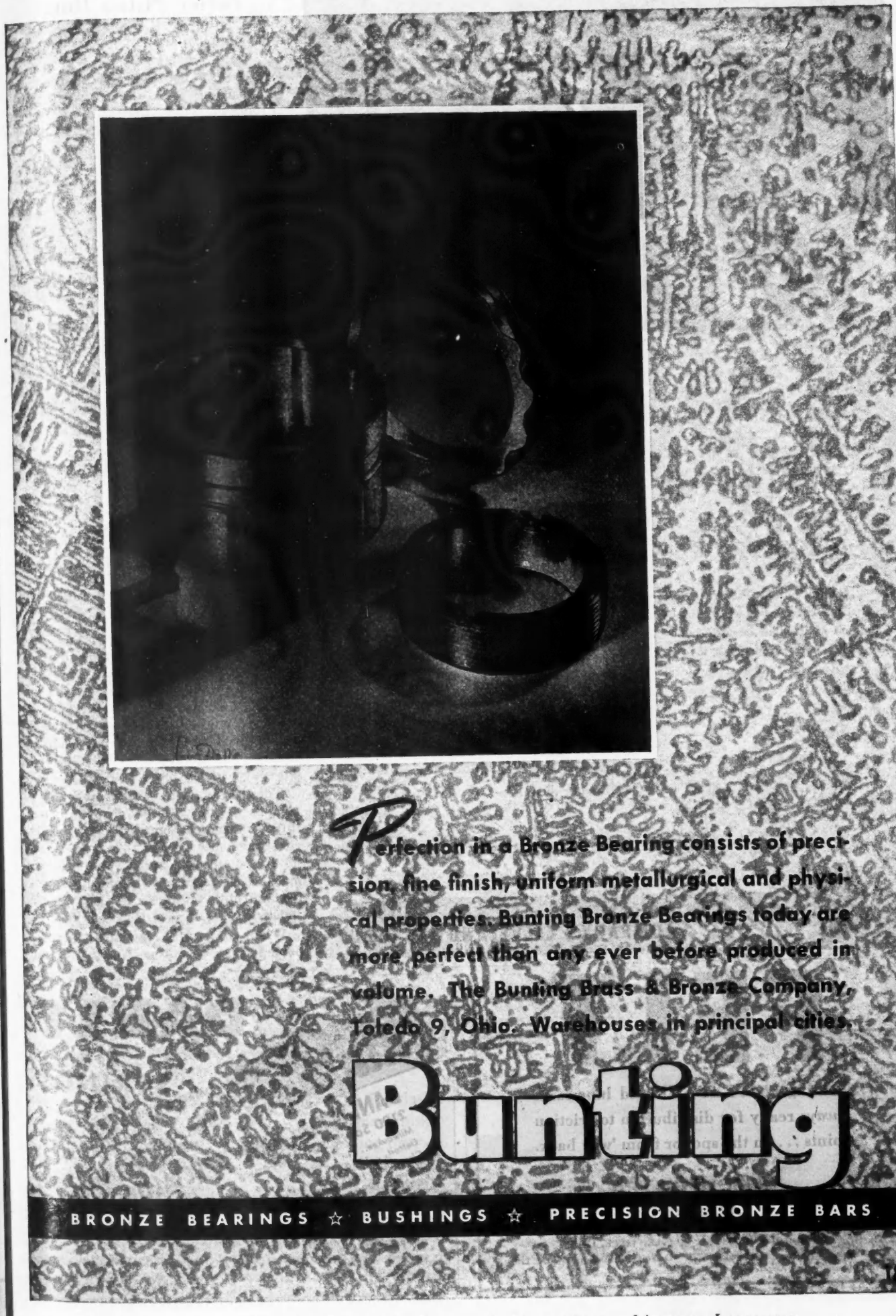
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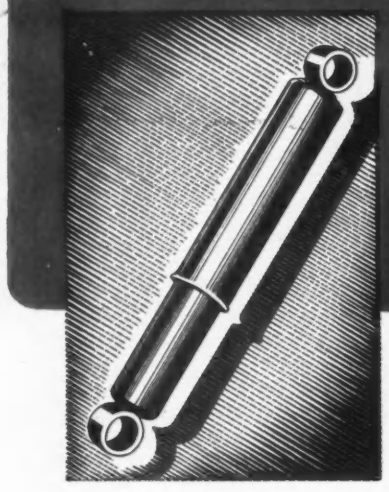

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Shocks Protect Tires

Nothing shortens tire life more than driving with worn, leaky, mal-adjusted shock absorbers. The experienced driver insists on Gabriels, and installs them when, and as he can get them.

Time was, when you thought of a shock absorber as something to save the rider. Now you know Gabriel Aerotype Hydraulic Shock Absorbers are engineered to save the car—and save the tires, too.

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The shock absorber business is the fastest growing line in the automotive parts business. Gabriel is the hottest line in the shock absorber business.

Write or wire today for particulars.

ARMY E NAVY

THE Gabriel COMPANY • CLEVELAND 14, OHIO

Better Piston Rings

(*Continued from page* 32)

excess of 75,000 psi, and another such composition, also alloyed with nickel, chromium, and molybdenum which, when heat treated, has a tensile strength of over 100,000 psi.

A recent SAE paper describes piston rings rolled from steel spring stock for certain special applications in high speed, high performance engines which demand higher ring pressures and greater strength for better oil control and freedom from breakage. These rings are of two types—one, relatively narrow in the axial direction and used in combination with cast iron or steel spacers; the other, made to full nominal groove width to replace cast iron rings. Obviously, such developments in special materials, stemming from full wartime experience, will be available to automotive designers to meet the special problems of post-war engines.

In recent years most piston ring producers have supplied rings with various types of thin protective coatings designed to resist erosion and abrasion during the break-in period; also as a protection against early rusting or corrosion. Among the general types of coating used for this purpose are: phosphates, cadmium, chromium, copper, and tin. Another treatment converts the raw cast iron surface into a black magnetic oxide. The most striking development along this line was the general adoption of porous or solid chromium plating by all producers, principally for aircraft and marine engines. Aircraft rings of rolled or forged steel have been employed, with a coating of 0.004-0.006 in. for particularly severe applications.

There has been considerable discussion as to the value of chromium plating in normal automotive engines. The consensus seems to be that while it will not be employed across the board, it may be desirable for special high-speed, high-output engines for heavy-duty trucks, buses, and Diesel engines.

When the piston ring manufacturers pooled their resources for the produc-

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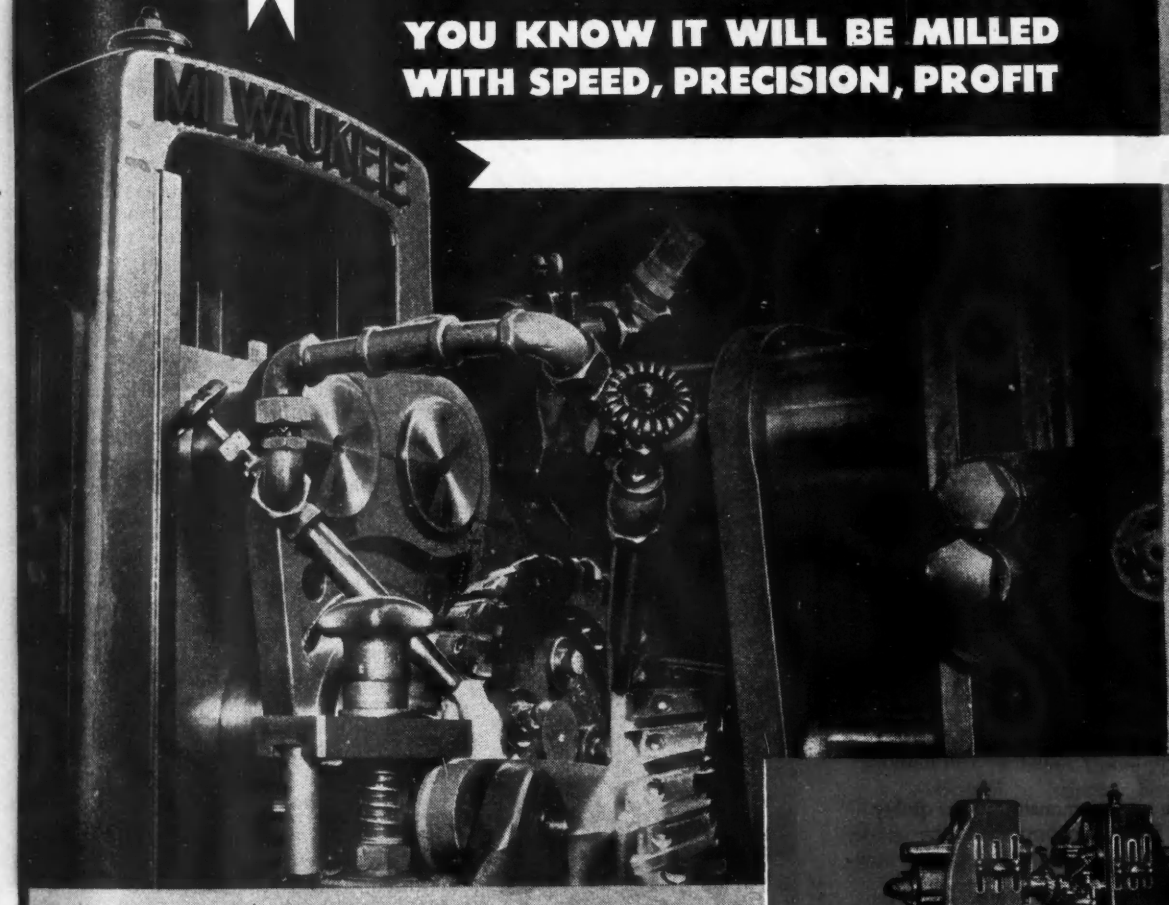
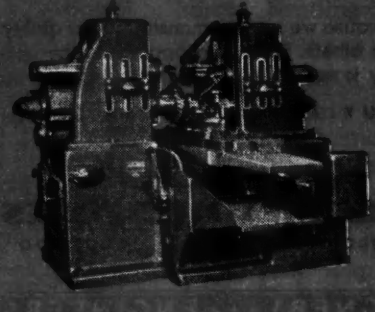


The straddle milling operation on this 1236 Milwaukee Duplex Milling Machine requires flexibility in spindle positioning because the milling cuts are at different levels. . . . Independent spindle speeds are necessary because the job required the use of two diameters of cutters. . . . "Anchoring" the spindle quill with the quill support mounted on the overarms, insures vibration-free operation in either "out" or "in" position.



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ARMY E NAVY

KEARNEY & TRECKER CORPORATION

MILWAUKEE 14, WISCONSIN

KNOWN as "production type" machines the Milwaukee Duplex series of milling machines offer important advantages:

— automatic trip table mechanism provides for continuous cycles of table movement.

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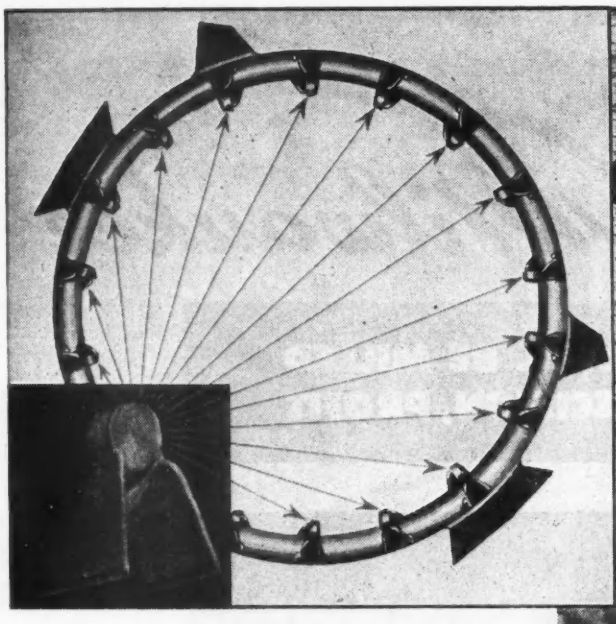
These features plus the compact rigidity and sturdiness designed and built into the machine assure fast, precision production at less cost. Write for new Bulletin No. B20, giving complete details on the Milwaukee Duplex and Simplex Series of Milling Machines.

Milwaukee Machine Tools



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tion of aircraft rings by the millions, where only small quantities had been made before, one of the seemingly insurmountable obstacles was the military requirement of parallel flat surfaces finished to ten micro-inches (1ms). Ultimately, each manufacturer, working in cooperation with equipment builders, developed techniques which not only met the specifications but made it possible to attain mass production speed and cost. Lapping machines used for this purpose are producing a finish of three micro-inches. A grinding process is yielding a finish of six to ten micro-inches and is currently being used on some automotive rings. In one case, at least, rings are being ground for all manner of applications to a finish of five to ten micro-inches at production rates of 200 per minute in automotive sizes. Here is an excellent example of a specification which did not exist before the war. It had to be met. And in meeting it, the industry was able to extend the principle to automotive rings without penalty.

In earlier days piston rings were made almost exclusively with machinery designed and patented by individual companies. In recent years there has been increasingly more exchange of information and technique, culminating in the pooling of all resources of the industry to meet the needs of the military aircraft program. Out of the pressure for more and more production, higher levels of quality and the need for lower costs came innumerable examples of machinery contributed by the machine tool industry. In many cases, conventional machinery was suitably modified through cooperation of the user and the builder. Today, the plants abound in machine tools bearing well-known names.

It is certain that the methods and detail improvements and the equipment installed during the war will have a revolutionary effect upon post-war piston ring production. This should be reflected in improved quality and in the opinion of some people promises a reduction in cost.

In piston rings quality control starts with the selection of the specific ring for a specific application. It runs the

HEAVY-DUTY BENCH-TYPE ENGRAVING MACHINE

THE PANTO MODEL UE-3

LIGHTER MODELS UE and UE-2

Interchangeable heads for engraving, electrical marking, and acid etching . . . available for all models. Also Panto engraving cutters, cutter grinders, master copy type, endless belts and accessories.

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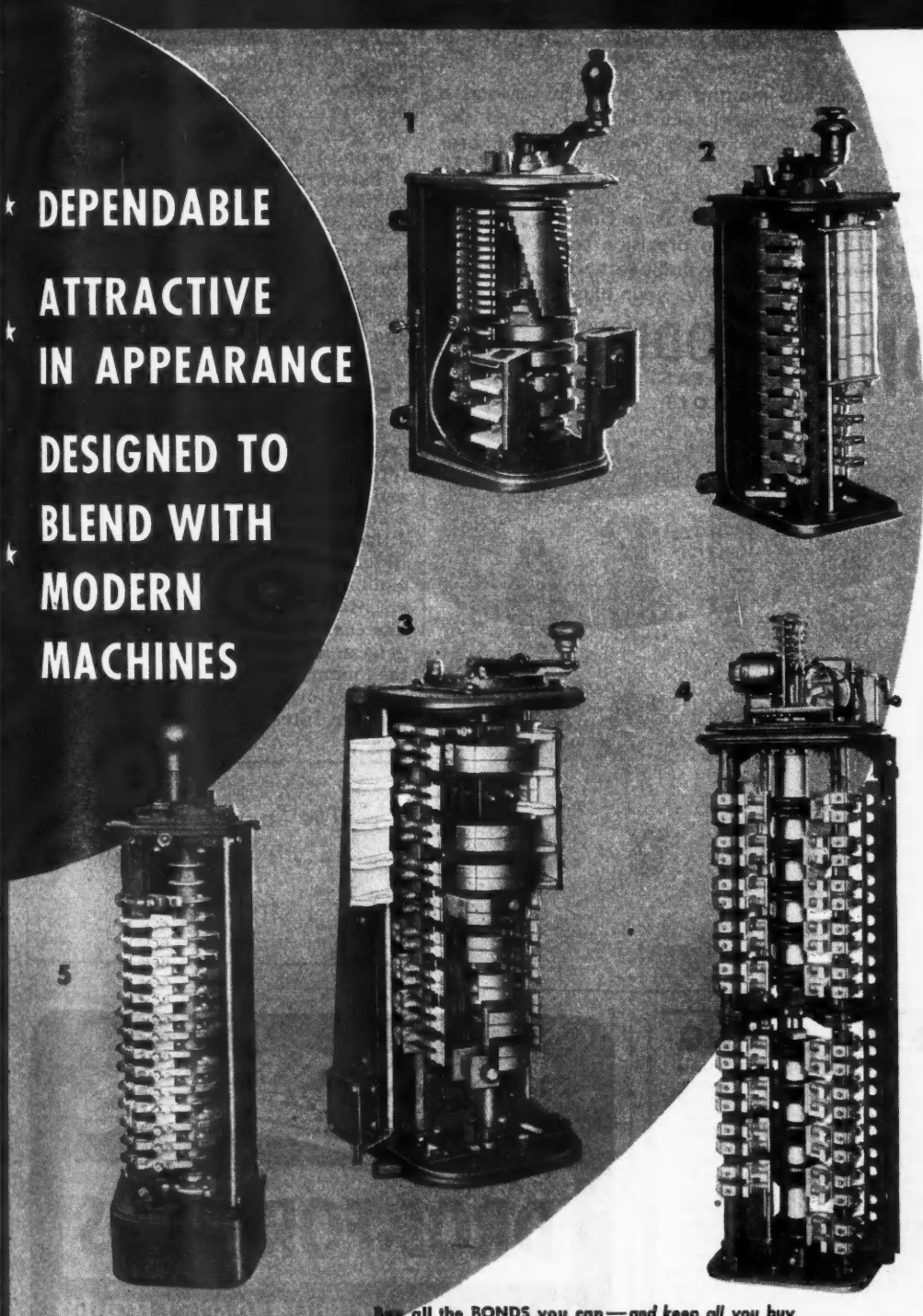

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For secondary control of wound-rotor motors that have three-phase secondaries. Designed for either remote operation, or as an automatic control when used with a pilot-circuit device.

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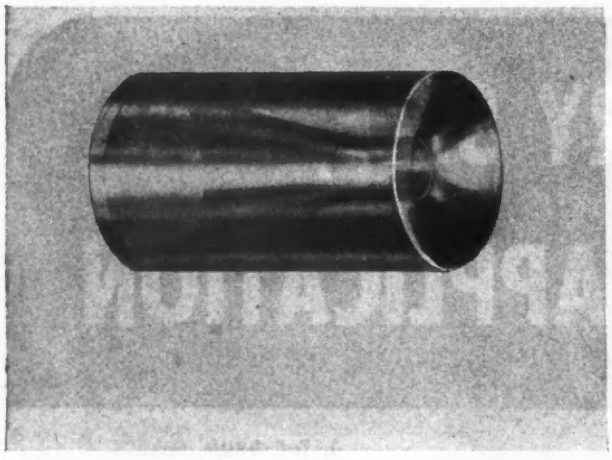

This is one of the group of samples of precision parts (illustrated below) of ferrous and non-ferrous alloys that have been made by BESSEMORE. On each of them the screw machine work was completed within ten and twenty-five seconds and .002" tolerances were maintained. The grinding work is held to .0001" (tenth).

A nozzle with a taper on one end, a curved mouthpiece on the other and a neck between . . . All of them must be held concentric one-to-the-other and also to the outside diameter within ± .0005" . . . The limits of the outside diameter and the inside diameter of the neck are + .0003 . . . —.0000. The limit of the length is ± .005 . . . The limit of the cone angle is ± 3 minutes. The material is X-1112 . . . literally and figuratively, it was a bottleneck problem in the war program. BESSEMORE specializes in precision screw machine manufacture . . . making more of them better. Our engineers will be glad to make recommendation without obligation . . . send us your blueprints.

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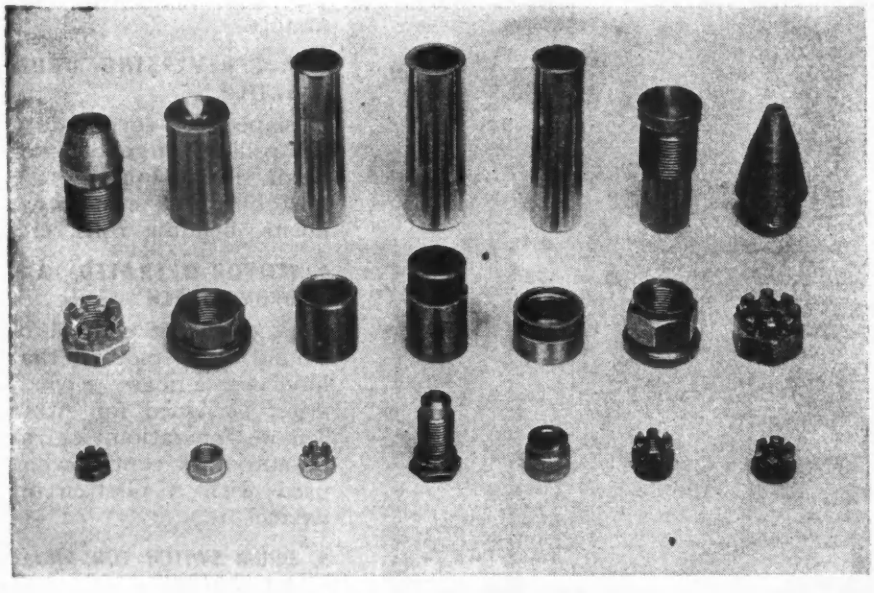

gamut of pattern design, molding techniques, and melting practice. Here will be found use of the X-ray, the spectrograph, and other methods of analysis; control of the sand for molding; control of pouring temperature, cooling rate, etc. When the castings enter the machine shop, quality control follows each individual step of the process, leading to the final inspection for dimensional accuracy, finish, spring characteristics, tension, and all other requirements.

Production of Steel

The operating rate of steel companies having 94 per cent of the steel capacity of the industry was 95.3 per cent of capacity for the week beginning May 14, compared with 95.1 per cent one week ago, 91.9 per cent one month ago and 99.2 per cent one year ago.

This represents an increase of 0.2 points or 0.2 per cent from the preceding week.

This week's operating rate is equivalent to 1,745,500 tons of steel ingots and castings, compared to 1,741,900 tons one week ago, 1,683,300 tons one month ago, and 1,777,000 tons one year ago.

Single Parts Supply Source

Borg-Warner International's aim to create a single source of supply for foreign importers of automobile, truck, and tractor functional parts has moved a step nearer realization with the addition of AP Parts Corporation, Toledo, Ohio, manufacturers of automobile mufflers and tail pipes. The new representation is the second announced in less than a week by J. L. Cunningham, general manager, and increases to 17 the manufacturers whose goods are supplied overseas distributors of Borg-Warner International.

The boys on the front still need letters from home

HARDNESS TESTING

The STANDARD SCLEROSCOPE (Now highly improved) for more than twenty years has made good and is still used for doing the world's hard work in testing. In general use for specifications purposes. Simple, Sturdy, Comparatively Inexpensive. Illustrated bulletins free. FOR QUALITATIVE AND QUANTITATIVE HARDNESS MEASUREMENT, under Static Pressure, the MONOTRON is the only machine now available. Operative up to over 2000 Diamond Brinell. Avoids errors due to spring in test pieces. Takes readings with the load on, avoiding reversal lash errors. No setting to zero. Operates at highest Speed. Has solved many old laboratory and shop problems. *We also make the Durometer for testing the hardness of rubber.* Comprehensive bulletins free.

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Write for Free Forging Data Folder . . . Helpful, Informative
J. H. WILLIAMS & CO., "The Drop-Forging People" BUFFALO 7, N.Y.

PUBLICATIONS

(*Continued from page* 48)

The Manhattan Rubber Mfg. Div. of Raybestos-Manhattan has issued a new friction **material catalog** describing an extensive line of friction materials available, including woven, folded and compressed, molded, semi-metallic and full-metallic.*

The B. F. Goodrich Co. has issued a new **28-page Rivnut Data Book.** Included are illustrated descriptions of the Rivnut and its generalized applications, descriptions of types, head styles and grip ranges. Charts show how to order the Rivnut by its proper number.*

A 46-page booklet **on Care and Maintenance of Airplane Tires and Tubes** has also been published by The B. F. Goodrich Co. Included is information on the function, construction and types of airplane tires and tubes, tire sizes, load and inflation tables.*

O'Neil-Irwin Mfg. Co. has published a 40-page booklet containing information and illustrations regarding the newest models of Di-Arco Precision Machines.*

Watson-Stillman Co. has issued Bulletin 640-A describing and illustrating the newly designed **Semi-Automatic Compression Molding Presses.** The Bulletin includes an engineering blueprint and specifications.*

The American Iron and Steel Institute, 350 Fifth Avenue, New York 1, has issued a revised edition of its booklet, **Steel Products Manual,** Hot-Rolled Carbon-Steel Strip, Section 12. Copies may be had by addressing the Institute at the above address.

The American Management Assoc. has available the following booklets in its **Personnel Series.** No. 83, Employer Responsibility for Veteran Reemployment, price $.75; No. 79, The New Pattern of Labor Relations, price $.50; No. 78, Reemployment of Veterans, price $.75; No. 87, The Foreman in Labor Relations, price $.50; No. 86, Practical Techniques of Collective Bargaining, price $.75; and No. 84, Personnel Policies of Reconversion, price $.75. Write to the Association at 330 W. 42nd Street, New York 18, for copies.

Printed copies of **Simplified Practice Recommendation R118-45, Abrasive Grain Sizes,** can be had by writing to the Supt. of Documents, Government Printing Office, Washington 25. Copies are 5c each.

A new bulletin on **non-magnetic uses of manganese steel** has been published by American Manganese Steel Div. of American Brake Shoe Co. Presented in the bulletin are studies with illustrations of typical applications where non-magnetism and the ability to withstand shock and wear were equally vital factors in the selection of manganese steel.*

* Obtainable by subscribers within the United States through Editorial Dept. AUTOMOTIVE *and* AVIATION INDUSTRIES. In making requests for any of these publications, refer to give date of the issue in which the announce appeared, your name and address, company connection and title.

Ingenious New
Technical Methods
Presented in the hope that they will prove interesting and useful to you.

Now! Shop Measurements to *One Millionth of an Inch*
With Simple Light Wave Setup!

The wave length of light is the basis for this amazing new optical measuring equipment—which measures millionths of an inch as easily as a micrometer measures tenths! All that is required, in addition to a simple setup, is average eyesight, intelligence and arithmetic.

As shown above, the work was placed under the Monochromatic Light, upon the work and gauge block—and covered by the optical flat. The light, reflected back to the operator, by the top and bottom surfaces of the optical flat, creates interference bands, representing height intervals of 11.6 millionths of an inch. So that from the center of one dark band to the center of the next, the level of the work has risen or fallen 11.6 millionths of an inch. The bands, simply, are a contour map of the surface. This fact, in a simple mathematical formula, is sufficient to explain all the shop uses of optical flats, and give the work measurement, quickly and accurately.

No longer, however, can your dealer give you Wrigley's Spearmint Gum. Today, under present conditions, this product cannot be manufactured up to Wrigley's quality standards. To protect consumer and dealer alike, the makers of Wrigley's Spearmint have decided to keep the quality Wrigley's Spearmint wrapper empty. Remember this wrapper, it means chewing gum of finest quality and flavor.

You can get complete information from
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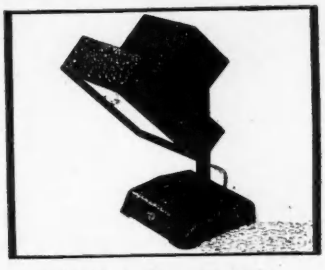
200 No. Laflin St., Chicago 7, Ill.



The Monochromatic Light.

Optical Flat. Surface of Work. Interpretation of bands on truly flat surfaces.

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Well-rated Chicago manufacturer of Diesel equipment and aircraft precision parts has opening for process engineer with ability to supervise tool designing department. Must have experience on jigs, fixtures, gauges and form tools. Give full experience and salary desired. Statement of availability required.

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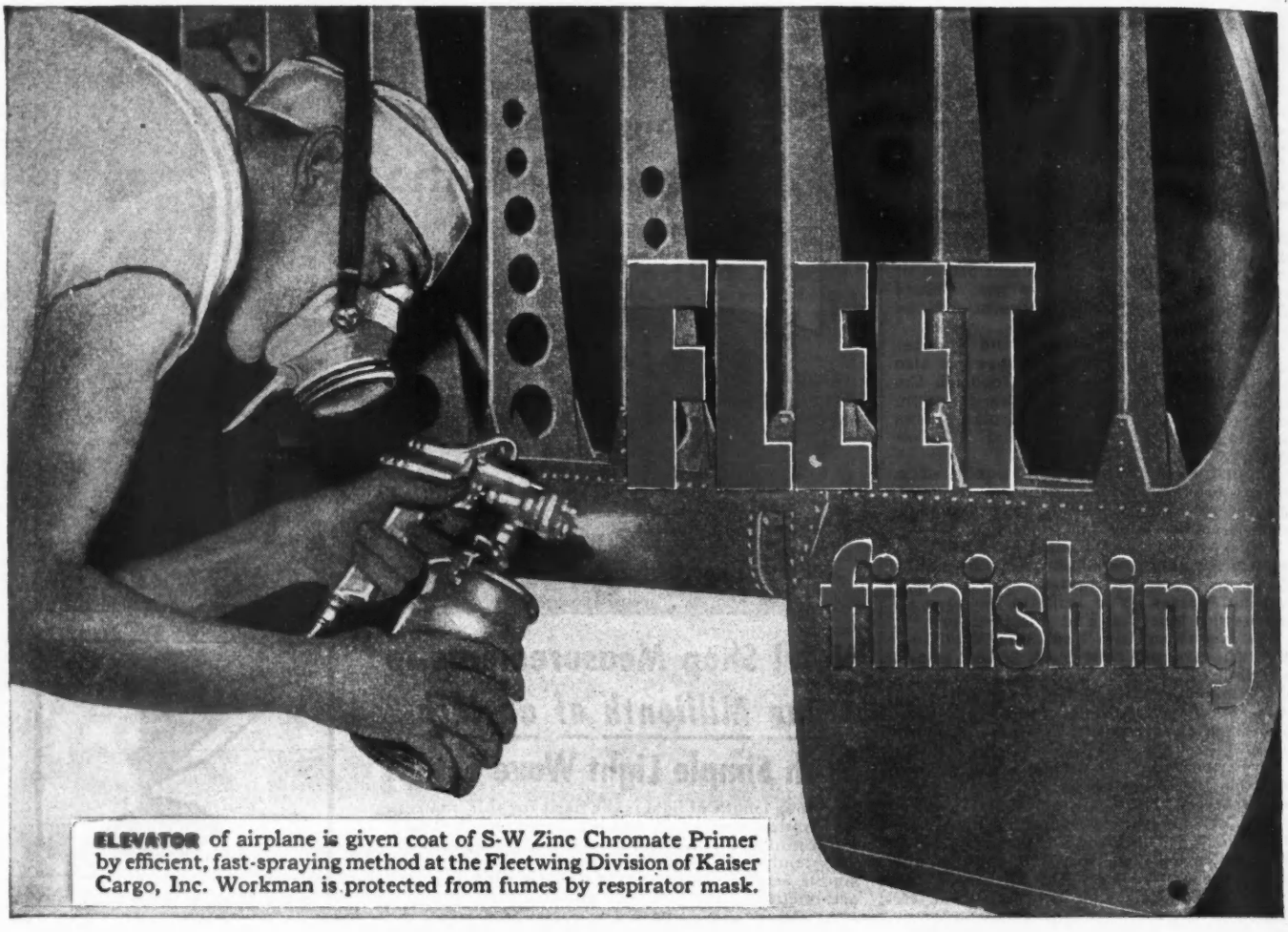
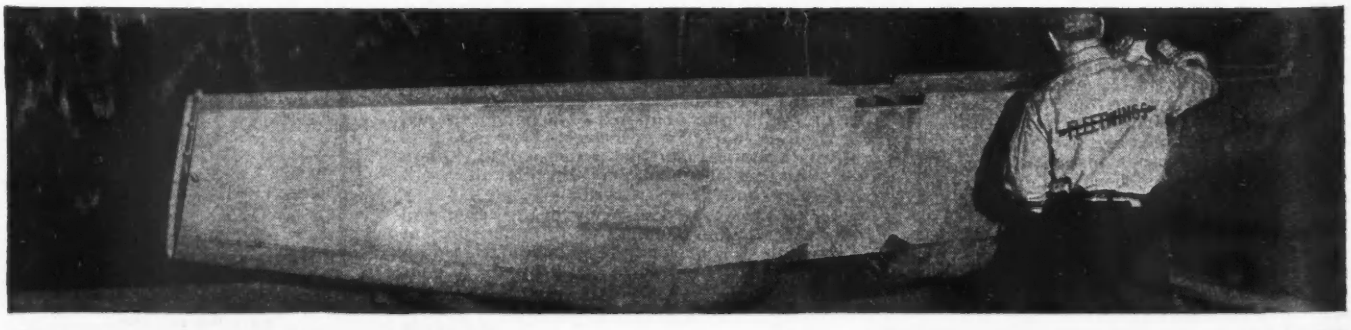
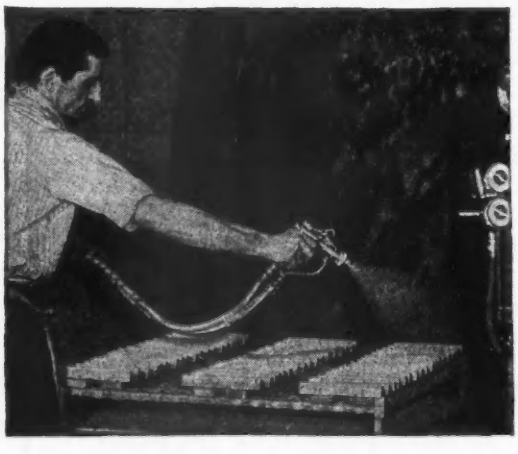


ELEVATOR of airplane is given coat of S-W Zinc Chromate Primer by efficient, fast-spraying method at the Fleetwing Division of Kaiser Cargo, Inc. Workman is protected from fumes by respirator mask.





EFFICIENT method of conveyor-hanging makes spraying easier. When finished, aileron is pulled up to ceiling to dry, thus saving valuable floor space!

ANGLES used in wing construction are sprayed with S-W Zinc Chromate Primer. Vacuum exhaust in modern finishing booth sucks away surplus paint, speeds drying!

STABILIZER is being sprayed with S-W Sea Blue Gloss Lacquer. Here again, vacuum exhaust and special lights simplify operation and speed production.

SHERWIN-WILLIAMS

[All photos courtesy of Kaiser Cargo, Inc., Fleetwing Division]

SHERWIN-WILLIAMS Helps Speed Production at KAISER CARGO, INC., FLEETWING DIVISION!

AT the Bristol, Pa., Fleetwing Division of Kaiser Cargo, Inc., airplane wings and control surfaces fly off production lines in typical "Kaiser" fashion... are soon part of famous Douglas, Boeing, Grumman, Chance Vought, Lockheed, Eastern Aircraft and other planes!

Helping to speed the many Fleetwing jobs are super fast-drying, extra-durable Sherwin-Williams Primers, Lacquers, Enamels, Dopes and Reducers. S-W technicians also supply special service facilities* and control standards that assure complete uniformity.

One more example of the way The Sherwin-Williams Co., one of the foremost suppliers of aviation finishes made to meet Army and Navy specification formulae, is aiding the American Aircraft Industry set production history!

We can help you, too! For details, write The Sherwin-Williams Co., Cleveland 1, Ohio.

*Among these services is the S-W perfected Thermotite doping system which is effecting revolutionary savings in time and labor. (THERMOTITE trade-mark Reg. U. S. Pat. Off.)

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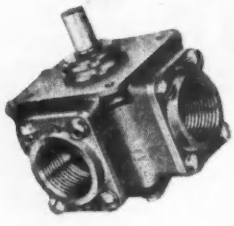

In helping to sustain fighting horsepower on the wing, Dole Aircraft Valves and Fittings have met the battle test in protecting the smooth functioning of gas, oil, air, oxygen and other vital supply lines—faithful proof of good design and engineering—and precision manufacture.

Out of the testing laboratory of war will come many improvements that will mean dependability in peacetime applications to aircraft and other industries.

DOLE Aircraft Valves and Fittings

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PERSONALS

(*Continued from page* 76)

Menasco Mfg. Co., **Ralph B. Smith,** Secretary.

A. O. Smith Corp., **John C. Dopke,** Sales Mgr., Automotive Div.; **Urban T. Kuechle** and **Milton E. Morgan,** assts. to Mr. Dopke.

Western Gear Works, **Roy Crawshaw,** Mgr. of Engineering and Sales.

Braniff Airways, **Horace Bolding,** Purchasing Agent.

Precision Welder and Mch. Co., **William G. Bostwick,** Chief Electrical Engineer.

General Controls Co., HI-G Div., **Lewis M. Horvath,** Divisional Sales Mgr.

Tung-Sol Lamp Works, Inc., **Harold F. Cook,** Adv. and Sales Promotional Mgr.

Westinghouse Electric Co., **William E. Miller, L. H. Lund** and **Ralph C. Stuart,** all elected vice-presidents. **Frank W. Godsey, Jr.,** Mgr. of New Products Div.; **John J. Hayes,** Pacific Coast District Treasury Mgr.

Mack Trucks, Inc., **Elliott G. Ewell,** Vice-Pres. and Mgr. Southern Div.

Minnesota Mining & Mfg. Co., **Earl F. Gregg,** Sales Engineer, Eastern Div.

United Aircraft Corp., Chance Vought Div., **Graham Reid,** Acting Purchasing Mgr.

United Air Lines, **Eric Johnston,** Pres. of U. S. Chamber of Commerce, elected a director.

Redmond Co., **D. L. Wertz,** special representative, headquarters in Detroit.

Adel Precision Products Corp., **Gordon S. Gillespie,** Comptroller and Secretary.

Consolidated Vultee Aircraft Corp., **Irving S. Babcock,** Chr. Board of Directors.

Pacific Airmotive Corp., **Victor E. Semrau,** Sec.-Treas.

Electrical Engineering & Mfg. Corp., **Gerhard Mauric,** Chief Engineer.

ACF-Brill Motors Co., **M. A. Hardie,** Treasurer.

Sterling Tool Products Co., **J. M. Warnimont,** Asst. Sales and Adv. Mgr.

Jack & Heintz, Inc., **Chauncey J. Lake,** Advertising Dept.

The White Motor Co., **Robert C. Lee,** Vice-Pres. and Treas.

Standards Products Co., **D. R. Stamy,** Vice-Pres. and Gen. Sales Mgr.

Kinner Motors, Inc., **John N. Gladden,** President, succeeding **Earl Herring,** resigned.

C. O. Bartlett & Snow Co., Transfer of **John J. Watson** to Detroit Sales Office.

Penn Metal Corp. of Penna., Lt. Col. **Hubert E. Snyder,** Vice-Pres.

GM Wins Safety Award

General Motors was named by the National Safety Council as a three-time winner of the Council's special wartime award for Distinguihed Service to Safety.

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Exceptional opportunities for research engineers, designers, checkers and draftsmen for immediate service on new fuel injection development. Permanent connection with old-line company. Only those who can qualify will be considered. Give complete details in first letter. Statement of availability required.

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What's going to happen to the SUZY Q?

Remember the graveyard of rusting ships after the last war? For years a grim reminder of surplus war production, they also represented a practically bankrupt shipbuilding industry.

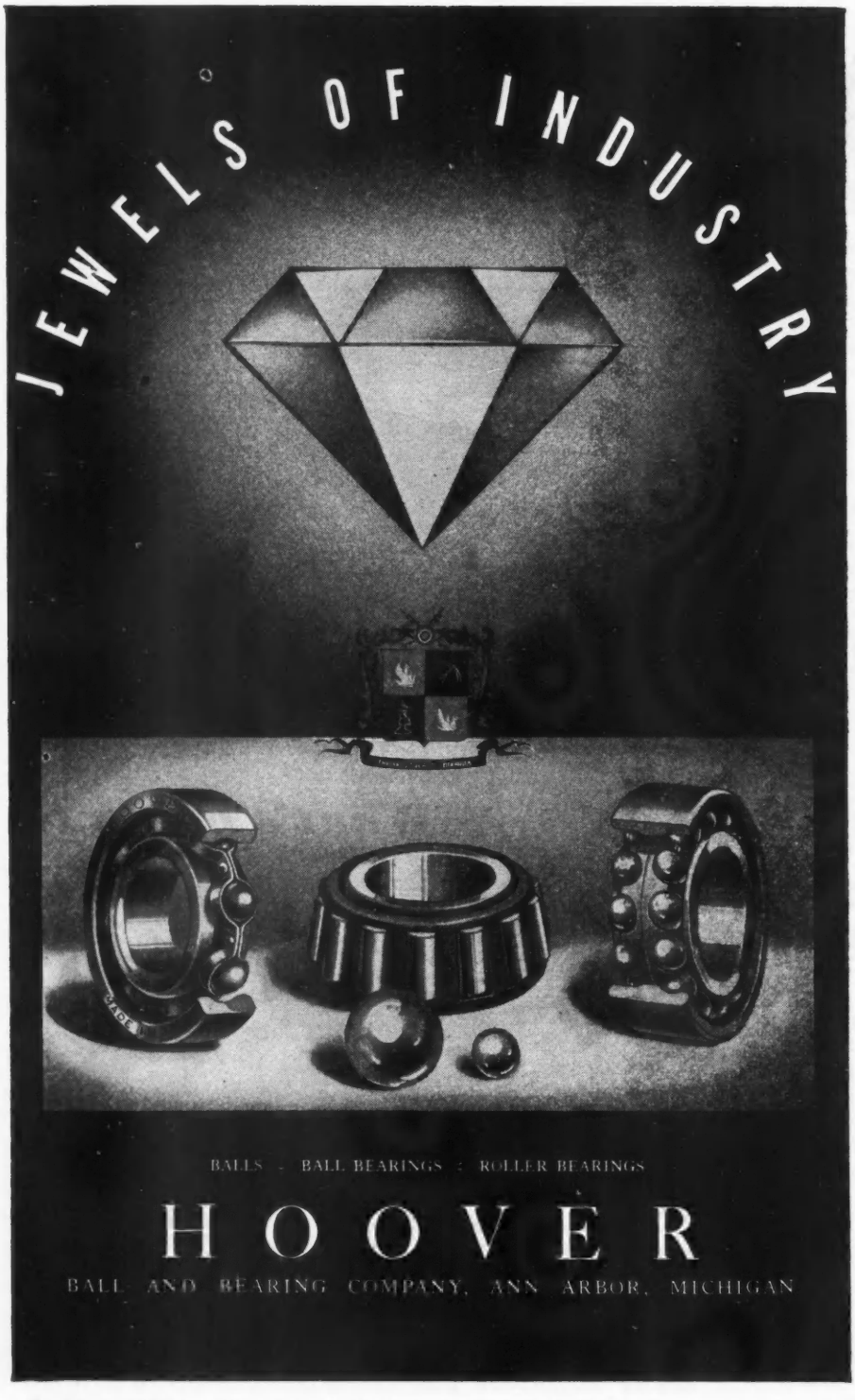
Today, America's aircraft industry accounts for a substantial proportion of our total national economy. That industry has produced more than a quarter of a million planes since Pearl Harbor! Its plants, equipment and production represent 50 billion dollars worth of taxpayers' money.

Here is the most valuable single peacetime legacy of war. . . . Here is power to maintain peace, insure our national security and provide jobs for millions of Americans . . . And here is a critical problem.

For the percentage of profit earned by our aircraft industry is so low that its entire capital reserves amount to only a few days' operating costs! The lack of a sound national airpower policy could actually result in the collapse of a great industry and the promise it holds for the whole world.

We at Bryant know that we can sell many machine tools to a healthy peacetime aircraft industry. But far more important — those tools mean jobs, and our last chance to enforce peace throughout the world.

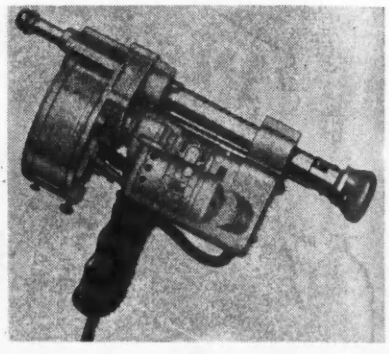
BRYANT CHUCKING GRINDER COMPANY SPRINGFIELD VERMONT, U.S.A.



New Production Equipment

(*Continued from page* 38)

THE "Screwmatic," a product of Reed-Prentice Corp., Worcester, Mass., is an automatic screw driver operated by air or electric power designed to drive screws in wood or metal. The self-filling magazine allows almost continuous operation with no hand feeding necessary. Each screw is driven to a predetermined depth as a gage on the spindle drive cuts off the torque and stops rotation of the blade.



Reed-Prentice automatic screw driver

Filling of the magazine is accomplished by a semi-automatic filler. Screws feed automatically into the chutes which lead to the nine fill channels. When the lever is pressed, the magazine indexes and only four stops are necessary. One refill machine services five Screwmatics.

STANDARD GAGE Co., Poughkeepsie, N. Y., has placed on the market the DuBo gage, a plug gage which offers several new features. The gage head is a relatively thin disk which is a section of a sphere. The spherical gaging surface makes contact with the bore wall only at the instant and point of bore gaging. Two chamfered sections, diametrically opposed, make it possible, by slightly tilting the handle, to enter the gage into bores easily. The DuBo can be used to check deep bores, as the

(*Turn to page* 110, *please*)

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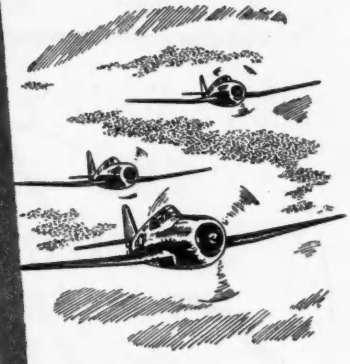
Auto-Lite

EQUIPMENT FOR AIRCRAFT

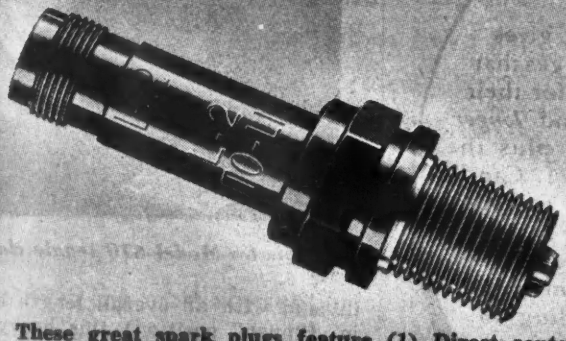


Wherever Allied fighting planes are flying you'll find electrical equipment precision-built by Auto-Lite. Its quality proved in the tough test of combat — equipment resulting from long years of careful development and research. Pictured here are a few examples of such equipment.

THE ELECTRIC AUTO-LITE COMPANY

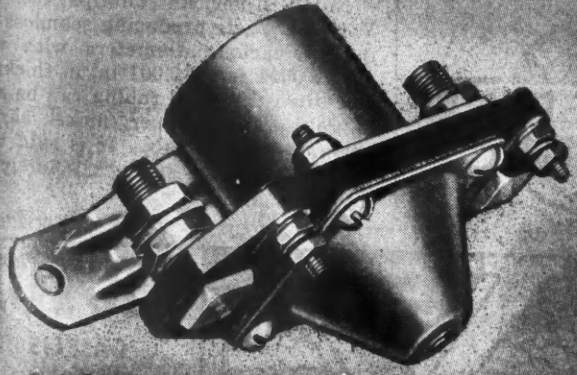
TOLEDO, 1, OHIO • SARNIA, ONTARIO

BUY WAR BONDS



These great spark plugs feature (1) Direct contact non-inductive resistor located in coolest position in plug; (2) Deep drawn nickel alloy center electrode tip; (3) Improved copper cooled center electrode; (4) High Dielectric strength and superior mechanical properties of "Corundum," Auto-Lite's insulator material.

Auto-Lite batteries are available in both 12 volt and 24 volt types. All are equipped with special non-spill vent plugs and assembled in either hard rubber or radio-shielded aluminum containers. The heavy duty battery has a capacity of 105 A.H. at 5 hr. rate; others have capacity of 34 A.H. at the 5 hr. rate.



Auto-Lite relays are available for both continuous and intermittent duty. They more than meet the most exacting Government requirements, giving dependable operation under extreme conditions of vibration, acceleration and altitude. Both types available are operative from minus 60 degrees F. to 160 degrees F.

The 5 mm. high tension ignition cable (left) has stainless steel conductor, rubber insulation, glass braid, neoprene sheath. Vega Chromoxide magnet wire (center) has heat resistant, space-saving qualities. Formvar magnet wire (right) has a special enamel with abrasive resistance 3 times that of conventional enamel wire.

AUTO-LITE

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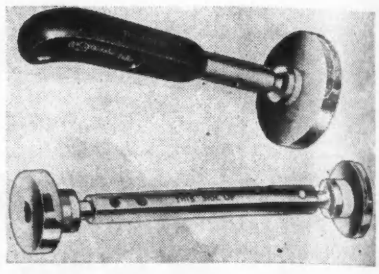
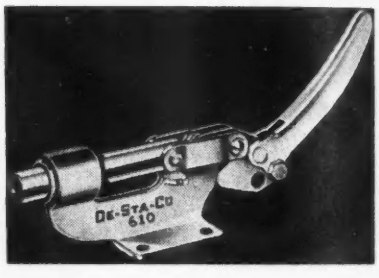


DuBo plug gages

handle may be tilted when applying the gage. The design permits gaging almost to the bottom of blind bores.

LATEST product of the Detroit Stamping Co., Detroit, Mich., is the De-Sta-Co Model 610 push-and-pull toggle clamp. This clamp can be converted from "push" to "pull" action—or vice versa—in a few seconds, by relocating one of the handle bolts. Weighing 1½



De-Sta-Co Model 610 toggle clamp

lb. and with an overall length of 6¾ in. ("push" position) this heavy duty model has a plunger rod travel of 1½ in. Rod is tapped to receive a ⅜ in.-16 standard threaded bolt, providing quick adjustment to the work being handled.

Ultra-Thin Tubing

North American Phillips Co., New York, N. Y., is producing seamless tubing of various diameters with walls only 0.0001 in. to 0.001 in. in thickness. The ultra-thin-wall tubing can be made of gold, silver, copper, nickel, chromium and other metals. It is said to be uniform in thickness and absolutely airtight.

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you wouldn't

lift a 500 pound load with a 100 pound capacity rope

It is just as foolish to put carbide cutting tools on an out-moded lathe. Carbide tools have increased horsepower requirements as much as 300 per cent.

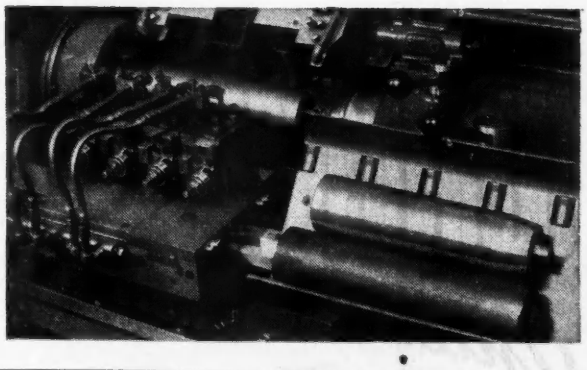
Modern Jones & Lamson Lathes are designed specifically to carry this extra load, and more. They have the power, they have the rigidity, they are easy to operate.

FOR PRODUCTION MEN THE BIGGEST BATTLE LIES AHEAD—the battle of costs. Our jobs, and our earnings, as well as profits, will depend upon maximum production from the most efficient machines.

Now is the time to check your equipment. Plan now to scrap obsolete machines and replace them with good War Surplus machines or new machines. Our engineers will be glad to assist you.

What HORSEPOWER Are You Using?

The 16" Fay Automatic Lathe that is rough turning this 105 millimeter shell has to transmit *from 75 to 100 horsepower* to do this job on a production basis and take full advantage of the fast cutting carbide tools.



Engineered to "Carry the Load" for Most Productive Operation With Carbide Cutting Tools

JONES & LAMSON
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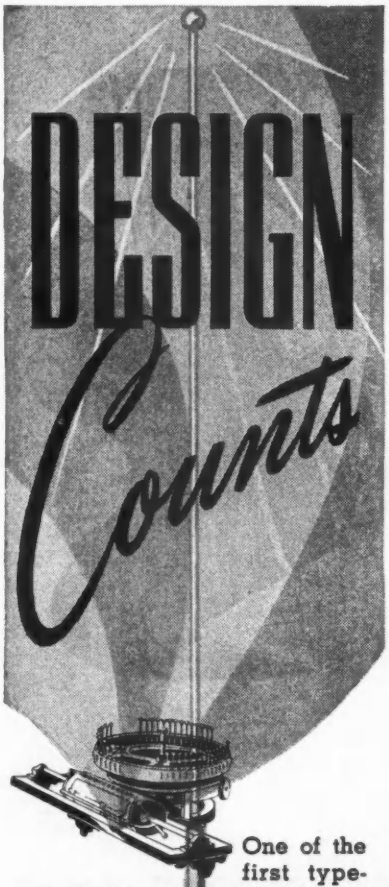
Fay Automatic Lathes

Manufacturer of: Universal Turret Lathes • Fay Automatic Lathes • Automatic Double-End Milling and Centering Machines • Automatic Thread Grinders • Optical Comparators • Automatic Opening Threading Dies and Chasers.



One of the first typewriters developed was that of Thurber in 1843. Then clumsy and slow, it has been brought to its present high level of efficiency and speed by careful application of design.

Here at THE WARD PRODUCTS CORPORATION Design Counts, also; because, it is only through superior design that the benefits of experience and the finest production facilities can best be brought to the user. For the finest antennas for all applications . . . for home and automobile use . . . look to WARD.

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GM Purchases Land for New Plants

Plans for the erection of an automobile assembly plant at Wilmington, Del., were announced by C. E. Wilson, president of General Motors. The plant, which will be built as soon as war conditions permit, will be used for the assembly of Buicks, Oldsmobiles and Pontiacs.

The new plant will be erected on a 125-acre site which has just been acquired by General Motors. It will be largely of one-story construction and will have approximately 1,000,000 square feet of floor space.

Depending on market requirements, it is anticipated that the plant, on a two-shift basis, would need approximately 3,000 employes.

The Wilmington plant will be one of a number of new plants planned by General Motors for post-war expansion. Plans previously have been announced for Fisher Body Division plants at Columbus, O., and Hamilton, O., and for a New Departure Division plant at Sandusky, O. Purchase of land near Kansas City, Mo., also has been announced by General Motors.

BOOKS . . .

VIBRATION ANALYSIS *by N. O. Myklestad, First Edition,* 303 *pp. Pub. McGraw-Hill.* This is the first edition of a textbook on vibration analysis, providing the best known methods of solving important vibration problems encountered in modern engineering work. The last chapter gives simple tabular methods of solution. Save for the problem of torsional vibration, the tabular methods have been developed by the author. The last chapter—applications to important practical problems—deals with problems of considerable complexity and is included for the benefit of vibration engineers.

Classified Advertisements

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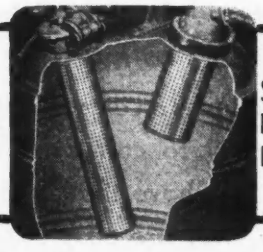

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PREVENT LOSS. Protectoseal Supply Cans prevent loss by evaporation because fill opening, spout, and special vent have automatic closures. The flexible spout eliminates waste and time lost fussing with funnels. The special vent permits fast pouring; a full five-gallon can can be emptied in less than a minute.

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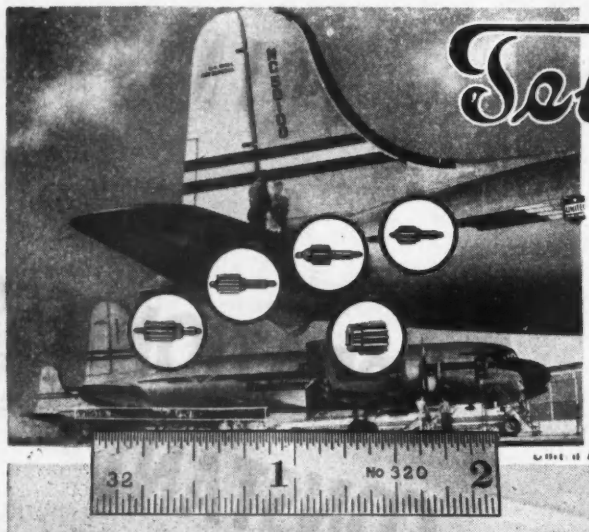

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New Car Quota

(*Continued from page 48*)

allotments to insure that military requirements will be met. All restrictions on dealer's inventories also will be removed.

Reconversion of the industry will require immediate construction valued at $29 million rather than the $35 million estimated to be required originally, according to a WPB survey. At the same time, WPB found that the industry will need only about $27 million worth of new tools to reach the "break-even" point as compared with early industry estimates of $50 million. For an all out or capacity quarterly rate of production amounting to $1,127,400,000 the construction cost will be $200 million. WPB further estimates that the industry would need $150 million worth of tools and equipment to establish capacity operations.

Cincinnati Warehouse for Carpenter Steel

The Carpenter Steel Company of Reading, Penna., has announced the opening of its new Cincinnati, Ohio warehouse, located at 5137 Vine Street, St. Bernard. This new warehouse will help the company better meet the demands for its tool, stainless and alloy steels required in the war program and for reconversion.

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